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THE SURFACE GEOLOGY OF THE BASIN OF THE GREAT LAKES AND THE VALLEY OF THE MISSISSIPPI.

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THE area bounded on the north by the Eozoic highlands of Canada, on the east by the Adirondacks and the Alleghanies, and on the west by the Rocky Mountains, though now, and apparently always, drained by two systems of water-courses, may be properly considered as one topographical district; since much of the water-shed which separates its two river systems is of insignificant height, is composed of unconsolidated "Drift" materials, has shifted its position hundreds of miles, as the water level in the great lakes has varied, and was for a long interval submerged beneath a water connection uniting both drainage systems in one.

In this great hydrographic basin the surface geology presents a series of phenomena of which the details, carefully studied in but few localities, still offer an interesting and almost inexhaustible subject of investigation, but which, as it seems to me, are already sufficiently well known to enable us to write at least the generalities of the history which they record.

The most important facts which the study of the "Drift

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phenomena" of this region have brought to light are briefly as follows:

1st. In the northern half of this area down to the parallels of 38°–40°, we find, not everywhere, but in most localities where the nature of the underlying rocks is such as to retain inscriptions made upon them, the upper surface of these rocks planed, furrowed or excavated in a peculiar and striking manner, evidently by the action of one great denuding agent. No one who has seen glaciers and noticed the effect they produce on the rocks over which they move, upon examining good exposures of the markings to which I have referred, will fail to pronounce them the tracks of glaciers.*

Though having a general north-south direction, locally the glacial furrows have very different bearings, conforming in a rude way to the present topography, and following the directions of the great lines of drainage.

On certain uplands, like those of the Wisconsin lead region, no glacial furrows have been observed (Whitney), but on most of the highlands, and in all the lowlands and great valleys, they are distinctly discernible if the underlying rock has retained them.

2d. Some of the valleys and channels which bear the marks of glacial action—evidently formed or modified by ice, and dating from the ice period or an earlier epoch—are excavated far below the present lakes and water-courses which occupy them.

These valleys form a connected system of drainage, at a lower level than the present river system, and lower than could be produced without a continental elevation of several hundred feet. A few examples will suffice to show on what evidence this assertion is based.

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*From my own observations on the action of glaciers on rock surfaces in the Alps and in Oregon and Washington Territory, I do not hesitate to assert that no other agent *could* have produced such effects. A different view is taken of this subject, it is true, but only by those who either have never seen a glacier or have never seen the markings in question. The track of a glacier is as unmistakable as that of a man or a bear.

Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario are basins excavated in undisturbed sedimentary rocks. Of these Lake Michigan is six hundred feet deep, with a surface level of five hundred and seventy-eight feet above tides; Lake Huron is five hundred feet deep, with a surface level of five hundred and seventy-four feet; Lake Erie is two hundred and four feet deep, with a surface level of five hundred and sixty-five feet; Lake Ontario is four hundred and fifty feet deep, with a surface level of two hundred and thirty-four feet above the sea.

An old, excavated, now-filled channel connects Lake Erie and Lake Huron. At Detroit the rock surface is one hundred and thirty feet below the city. In the oil region of Bothwell, etc., from fifty to two hundred feet of clay overlie the rock. What the greatest depth of this channel is, is not known.

An excavated trough runs south from Lake Michigan—filled with clay, sand, tree trunks, etc.—penetrated at Bloomington, Illinois, to the depth of two hundred and thirty feet.

The rock bottoms of the troughs of the Mississippi and Missouri, near their junction or below, have never been reached, but they are many feet, perhaps some hundreds, beneath the present stream-beds.

The borings for oil in the valleys of the Western rivers have enabled me not only to demonstrate the existence of deeply buried channels of excavation, but in many cases to map them out. Oil Creek flows from seventy-five to one hundred feet above its old channel, and that channel had sometimes vertical and even overhanging cliffs. The Beaver, at the junction of the Mahoning and Shenango, runs one hundred and fifty feet above the bottom of its old trough.

The Ohio throughout its entire course runs in a valley which has been cut nowhere less than one hundred and fifty feet below the present river.

The Cuyahoga enters Lake Erie at Cleveland, more than

one hundred feet above the rock bottom of its excavated trough. The Chagrin, Vermilion, and other streams running into Lake Erie exhibit the same phenomena, and prove that the surface level of the lake must have once been at least one hundred feet lower than now.

The bottom of the excavated channel in which Onondaga Lake is situated, and the Salina salt-wells bored, is at least four hundred and fourteen feet below the surface level of the lake and fifty feet below the sea level. (Geddes, Trans. New York State Agricultural Society, 1859.)

The old channel of the Genesee River at Portage, described by Professor Hall in the Geology of the Fourth District of New York; the trough of the Hudson, traceable on the sea bottom nearly one hundred miles from the present river mouth; the deeply buried bed of the Lower Mississippi, are additional examples of the same kind; while the depth to which the Golden Gate, the Straits of Carquinez, the channel of the lower Columbia, the Canal de Haro, Hood's Canal, Puget Sound, etc., have been excavated, indicates a similar (perhaps simultaneous) elevation and erosion of the Western coast of America.

The falls of the Ohio—formed by a rocky barrier across the stream—though at first sight seeming to disprove the theory of a deep continuous channel in our Western rivers, really afford no argument against it, for here, as in many other instances, the present river does not follow accurately the line of the old channel below, but runs along one or the other side of it. In the case of the Louisville falls the Ohio runs across a rocky point which projects into the old valley from the north side, while the deep channel passes under the lowland on the south side, on part of which the city of Louisville is built.

The importance of a knowledge of these old channels in the improvement of the navigation of our larger rivers is obvious, and it is possible it would have led to the adoption of other means than a rock canal for passing the Louisville

falls, had it been possessed by those concerned in this enterprise.

I ventured to predict to General Warren that an old filled-up channel would be found passing around the Mississippi rapids, and his examinations have confirmed the prophecy. I will venture still farther, and predict the discovery of buried channels of communication between Lake Superior and Lake Michigan — probably somewhere near and east of the Grand Sable — at least, between the Pictured Rocks and the St. Mary's River — between Lake Erie and Lake Ontario through Canada, — between Lake Ontario * and the Hudson by the valley of the Mohawk, — between Lake Michigan and the Mississippi, somewhere along the line I have before indicated. I also regard it probable that a channel may be found connecting the upper and lower portions of the Tennessee River, passing around the Mussel Shoals. This locality lies outside of the area where the Northern Drift deposits were laid down to fill and conceal ancient channels, but the excavation and the filling up of the channel of the Tennessee — like that of the Ohio — were determined by the relative altitude of the waters of the Gulf. The channel of the Lower Tennessee must have been excavated when the southern portion of the Mississippi valley was higher above the Gulf level than now, and Professor Hilgard has shown that at a subsequent period, probably during the Champlain epoch, the Gulf coast was depressed five hundred feet below its present relative level. This depression must have made the Lower Mississippi an arm of the sea, by which the flow of the Ohio

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* When the water in the lake basin had subsided to near its present level, its old avenues of escape being all silted up by the Drift clays and sands, the surplus made its exit by the line of lowest levels wherever that chanced to run. As that happened to lie over the rocky point that projected from the northern extremity of the Alleghanies into the lake basin, there the line of drainage was established in what is now known as Niagara River.

Though among the most recent of the events recorded in our surface geology, this choice of the Niagara outlet by the lake waters was made so long ago that all the erosion of the gorge below the falls has been accomplished since. The excavation of the basin into which the Niagara flows — the basin of Lake Ontario, of which Queenstown Heights form part of the margin — belongs to an epoch long anterior.

and Tennessee was arrested, their channels filled, terraces formed, etc. If the Upper Tennessee has, as appears, a channel lower than the Mussel Shoals, it must be somewhere connected with the deep channel of the lower river.

It should be said, however, that it by no means follows that where an old earth-filled channel passes around the rocky barrier by which the navigation of our rivers is impeded, it will be most convenient and economical to follow it in making a canal to pass the obstacle, as the course of the old channel may be so long and circuitous that a short rock cutting is cheaper and better. The question is, however, of sufficient importance to deserve investigation, before millions of dollars are expended in rock excavation.

If it is true that our great lakes can be connected with each other and with the ocean, both by the Hudson and Mississippi, by ship canals, — in making which no elevated summits nor rock barriers need be cut through,—the future commerce created by the great population and immense resources of the basin of the great lakes may require their construction.

3d. Upon the glacial surface we find a series of unconsolidated materials generally stratified, called the "Drift deposits."

Of these the first and lowest are blue and red clays (the Erie clays of Sir William Logan), generally regularly stratified in thin layers, and containing no fossils, but drifted coniferous wood and leaves. Over the southern and eastern part of the lake basin, these clays contain no boulders, but towards the North and West they include scattered stones, often of a large size; while in places beds of boulders and gravel are found resting directly on the glacial surface.

In Ohio the Erie clays are blue, nearly two hundred feet in thickness, and reach up the hill-sides more than two hundred feet above the present surface of Lake Erie. On the shores of Lake Michigan these clays are in part of a red color, showing that they have been derived from different rocks, and they there include great numbers of stones.

On the peninsula between Lake Erie and Lake Huron the Erie clays fill the old channel which formerly connected these lakes, having a thickness of over two hundred feet, and containing a few scattered stones.

4th. Above the Erie clays are sands of variable thickness and less widely spread than the underlying clays. These sands contain beds of gravel, and, near the surface, teeth of elephant have been found, water-worn and rounded.

5th. Upon the stratified clays, sands, and gravel of the Drift deposits are scattered boulders and blocks of all sizes, of granite, greenstone (diorite and dolerite), silicious and mica slates, and various other metamorphic and eruptive rocks, generally traceable to some locality in the Eozoic area north of the lakes. Among these boulders many balls of native copper have been found, which could have come from nowhere else than the copper district of Lake Superior.

Most of these masses are rounded by attrition, but the large blocks of Corniferous limestone which are scattered over the southern margin of the lake basin in Ohio show little marks of wear. These masses, which are often ten to twenty feet in diameter, have been transported from one hundred to two hundred miles south-eastward from their places of origin, and deposited sometimes three hundred feet above the position they once occupied.

6th. Above all these Drift deposits, and more recent than any of them, are the "lake ridges,"—embankments of sand, gravel, sticks, leaves, etc., which run imperfectly parallel with the present outlines of the lake margins, where highlands lie in the rear of such margins. Of these, the lowest on the South shore of Lake Erie is a little less than one hundred feet above the present lake level; the highest, some two hundred and fifty feet. In New York, Canada, Michigan, and on Lake Superior, a similar series of ridges has been discovered, and they have everywhere been accepted as evidence that the waters of the lakes once reached the points

which they mark. That they are nothing else than ancient lake beaches we shall hope to prove farther on.

In the southern half of the Mississippi valley the evidences of glacial action are entirely wanting, and there is nothing corresponding to the wide-spread Drift deposits of the north. We there find, however, proofs of erosion on a stupendous scale, such as the valley of East Tennessee, which has been formed by the washing out of all the broken strata between the ridges of the Alleghanies and the massive tables of the Cumberland Mountains,—the cañons of the Tennessee, one thousand six hundred feet deep, etc. Here also, as in the lake basin, the channels of excavation pass far below the deep and quiet waters of the lower rivers; proving by their depth that they must have been cut when the fall of these rivers was much greater than now.

The history which I derive from the facts cited above is briefly this:

1st.—That in a period probably synchronous with the glacial epoch of Europe,—at least corresponding to it in the sequence of events,—the northern half of the continent of North America had a climate comparable with that of Greenland; so cold, that wherever there was a copious precipitation of moisture from oceanic evaporation, that moisture was congealed and formed glaciers which flowed by various routes towards the sea.

2nd.—That the courses of these ancient glaciers corresponded in a general way with the present channels of drainage. The direction of the glacial furrows proves that one of these ice rivers flowed from Lake Huron, along a channel now filled with drift, and known to be at least one hundred and fifty feet deep, into Lake Erie, which was then not a lake, but an excavated valley into which the streams of Northern Ohio flowed, one hundred feet or more below the present lake level. Following the line of the major axis of Lake Erie to near its eastern extremity, here turning north-east, this glacier passed through some channel on the Cana-

dian side, now filled up, into Lake Ontario, and thence found its way to the sea either by the St. Lawrence or by the Mohawk and Hudson. Another glacier occupied the bed of Lake Michigan, having an outlet southward through a channel—now concealed by the heavy beds of drift which occupy the surface about the south end of the lake—passing near Bloomington, Illinois, and by some route yet unknown reaching the trough of the Mississippi, which was then much deeper than at present.

3D.—At this period the continent must have been several hundred feet higher than now, as is proved by the deeply excavated channels of the Columbia, Golden Gate, Mississippi, Hudson, etc., which could never have been cut by the streams that now occupy them, unless flowing with greater rapidity and at a lower level than they now do.

The depth of the trough of the Hudson is not known, but it is plainly a channel of erosion, now submerged and become an arm of the sea. As has been before stated this channel is marked on the sea-bottom for a long distance from the coast and far beyond a point where the present river could exert any erosive action, and hence it is a record of a period when the Atlantic coast was several hundred feet higher than now.

The lower Mississippi bears unmistakable evidence of being—if one may be permitted the paradox—a half-drowned river; that is, its old channel is deeply submerged and silted up, so that the "father of waters," lifted above the walls that formerly restrained him, now wanders, lawless and ungovernable, whither he will in the broad valley.

The thickness of the delta deposits at New Orleans is variously reported from fifteen hundred feet upwards, the discrepancies being due to the difficulty of distinguishing the alluvial clays from those of the underlying Cretaceous and Tertiary formations. It is certain, however, that the bottom of the ancient channel of the Mississippi has never been reached between New Orleans and Cairo; the instances cited

by Humphreys and Abbot in their splendid study of this river being but repetitions of the phenomena exhibited at the falls of the Ohio—the river running over *one side* of its ancient bed.

The trough of the Mississippi is not due to synclinal structure in the underlying rocks, but is a valley of erosion simply. Ever since the elevation of the Alleghanies—*i.e.* the close of the Carboniferous period—it has been traversed by a river which drained the area from which flow the upper Mississippi, the Ohio, the Tennessee, etc. Since the Miocene period, the Missouri, Arkansas, and Red rivers have made their contributions to the flood that flowed through it. The depth to which this channel is cut in the rock proves that at times the river must have flowed at a lower level and with a more rapid current than now; while the Tertiary beds formed as high as Iowa and Indiana in this trough, and the more modern Drift clays and boulders which partially fill the old rock cuttings, show that the mouth and delta of the river have, in the alternations of continental elevation, travelled up and down the trough at least a thousand miles; and that not only is it true, as asserted by Ellet, that every mile between Cairo and New Orleans once held the river's mouth, but that in the several advances and recessions of the waters of the Gulf the mouth has been more than twice at each point. The change of place of the delta has been caused, however, for the most part, by oscillations of the sea level, and not, as Ellet supposed, by the filling of the channel by the materials transported by the river itself.

Drift Deposits. The Drift deposits which cover the glacial surface, consisting of fine clays below, sands and gravel above, large transported boulders on the surface, and the series of lake ridges (beaches) over all, form a sequence of phenomena of which the history is easily read.

Erie Clays. The lower series of blue or red clays—the "Erie clays" of Sir William Logan—over a very large area, rest directly on the plain and polished rock surfaces. These

clays are often accurately stratified, were apparently deposited in deep and generally quiet water, and mark a period when the glacial ice-masses, melted by a change of climate, retreated northward, leaving large bodies of cold fresh-water* about their southern margins, in which the mud produced by their grinding action on the paleozoic rocks of the Lake District was first suspended and then deposited.

On the shores of Lake Erie these clays contain no boulders and very few pebbles, while farther North and West boulders are more abundant. This is precisely what might be expected from the known action of glacial masses on the surfaces over which they pass. Their legitimate work is to grind to powder the rock on which they rest; an effect largely due to the sand which gathers under them, acting as emery on a lead wheel. The water flowing from beneath glaciers is always milky and turbid from this cause. Rocks and boulders are sometimes frozen into glaciers, and thus transported by them, but nearly all the boulders carried along by a glacier are such as have fallen from above; and a moraine can hardly be formed by a glacier except when there are cliffs and pinnacles along its course.

In a nearly level country, composed of sedimentary rocks passed over by a glacier, we should have very little débris produced by it, except the mud flour which it grinds.

The Erie clays would necessarily receive any gravel or stones which had been frozen into the ice, either as scattered pebbles or stones, distributed to some distance from the glacial mass by floating fragments of ice, or as masses of frozen gravel, or larger and more numerous boulders near the glacier. In some localities torrents would pour from the sides and from beneath the glacier, so that here coarse material would alone resist the rapid motion of the water, and the stratification of the sediments would be more or less confused.

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* *Cold*, because coming from the melting glacier, and depositing with its sediments no evidences of life; *fresh*, because no marine shells are found in it—only drift-wood—while the equivalent "Champlain" clays on the coast are full of Marine Arctic shells.

In regard to the *cause* of the gradual amelioration of the climate of the glacial epoch, by which the great glaciers of the lake basin were driven northward and finally altogether dissolved, we are not left entirely to conjecture.

Cosmical causes possibly and probably had the chief agency in producing this result, but we have unmistakable evidence of at least the coöperation of another and perhaps no less potent cause, namely, continental depression.

If a cosmical cause had simply increased the annual temperature till the glaciers were all melted, without the action of any other agent, we should never have had the accumulation of drift deposits which now occupy all the glacial area; but the drainage streams, changed in all their courses from ice to water, would have flowed freely and rapidly away through their deeply cut channels to deposit their abundant sediments only where their transporting power was arrested, in the depths of the ocean.

Instead of this, we everywhere find evidence that this flow was checked, and a basin of quiet water formed by an advance of the ocean consequent upon a subsidence of the land. On the Atlantic and Gulf coasts this depression progressed until the sea level was more than five hundred feet higher than now. The effect of this depression was to deeply submerge the eastern margin of the continent, and cover it with the "Champlain" clays.

It is evident that at this period the drainage from the great water-shed of the continent must have been met by the quiet waters of the ocean almost at the sources of the present draining streams, and as the "dead water" gradually crept up the valleys, arresting the transporting power of their currents, their old channels would be silted up and obliterated, and their valleys partially filled with materials for their subsequent terraces. In the advance and subsequent recession of the line of "dead water" we have ample cause for all our terrace phenomena.

This continental depression accounts satisfactorily for the

filling of the old channels of the Mississippi and the Ohio, as a depression of five hundred feet would bring the ocean nearly to Pittsburgh on the Ohio, to St. Paul on the Mississippi.

But I think we have evidence that the continent did not sink uniformly in all its parts, but *most at the North.* Not to cite any other proof of this,—northern coast fiords, etc. —the altitude of the loess-like deposits of the upper Mississippi and Missouri (the lacustrine non-glacial sediments of this period of submergence), the upward reach of the Drift clays of the lake basin, the filling of the valleys of the streams flowing into the Ohio and Lake Erie, the old lake beaches marking the former water-level in the lake basin—all indicate that the continental subsidence was greatest towards the north. To this subsidence we must, as I think, attribute the accumulation of water in the lake basin and Mississippi valley to form the great inland sea of fresh-water, of which traces everywhere abound. It seems to me scarcely necessary to suppose any other barriers by which this sea was enclosed than the highlands that encircle it—such as are roughly outlined by the light tint on Professor Guyot's map of North America—and the sea-water which filled the mouths of the two* straits by which it communicated with the ocean.

Yellow Sands and Surface Boulders. I have mentioned that on the Erie clays are beds of gravel, sand, and clay, and over these again great numbers of transported boulders, often of large size and of northern and remote origin.

These surface deposits have been frequently referred to as the direct and normal product of glacial action, the materials torn up and scraped off by the great ice ploughs in their

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* If there *were* two. That there was one in the course of the Mississippi we know, and that so long that, though salt at one end, it must have been fresh at the other.

The eastern outlet of the lake waters may not have been by the St. Lawrence but as likely through the gap between the Adirondacks and the Alleghanies. The shallow channels between the Thousand Islands and the Lachine Rapids seem to indicate that the St. Lawrence is a comparatively *new* line of drainage for the lakes.

long journeys from the North; in fact, as some sort of huge terminal and lateral moraines. I have, however, disproved, as I think, this theory of their transportation in a paper published some years since (Notes on the Surface Geology of the Basin of the Great Lakes. Proc. Bost. Nat. Hist. Soc. 1863), in which it is urged that the continuous sheet of the Erie clays upon which they rest, and which forms an unbroken belt between them and their place of origin, precludes the idea that they have been transported by any ice-current or rush of water moving over the glacial surface; as either of these must have torn up and scattered the soft clays below.

There is, indeed, no other conclusion deducible from the facts than that these sands, gravels, granite and greenstone boulders—masses of native copper, etc., which compose the superficial Drift deposits—have been *floated* to their resting-places, and that the floating agent has been ice, in the form of *icebergs;* in short, that these materials have been transported and scattered over the bottom and along the south shore of our ancient inland sea, just as similar materials are now being scattered over the banks and shores of Newfoundland.

If we restore in imagination this inland sea, which we have proved once filled the basin of the lakes, gradually displacing the retreating glaciers, we are inevitably led to a time in the history of this region when the southern shore of this sea was formed by the highlands of Ohio, etc., the northern shore a wall of ice resting on the hills of crystalline and trappean rocks about Lake Superior and Lake Huron.

From this ice-wall masses must from time to time have been detached,—just as they are now detached from the Humboldt Glacier,—and floated off southward with the current, bearing in their grasp sand, gravel, and boulders—whatever composed the beach from which they sailed. Five hundred miles south they grounded upon the southern shore; the highlands of now Western New York, Pennsylvania and

Ohio, or the shallows of the prairie region of Indiana, Illinois, and Iowa; there melting away and depositing their entire loads,—as I have sometimes seen them, a thousand or more boulders on a few acres, resting on the Erie clays and looking in the distance like flocks of sheep,—or dropping here and there a stone and floating on, east or west, till wholly dissipated.

These boulders include representatives of nearly all the rocks of the Lake Superior country, conspicuous among which are granites with rose-colored orthoclase, gray gneiss, and diorites, all characteristic of the Laurentian series; hornblendic rocks, massive or schistose, and dark greenish or bluish silicious slates, probably from the Huronian; dolorites and masses of native copper, apparently from the Keweenaw Point copper region.

In the Drift gravels I have found pebbles and small boulders of nearly all the paleozoic rocks of the lake basin, containing their characteristic fossils, namely, the Calciferous Sandrock with *Maclurea*, Trenton and Hudson with *Ambonychia radiata*, *Cyrtolites ornatus*, Medina with *Pleurotomaria litorea*, Corniferous with *Conocardium trigonale*, *Atrypa reticularis*, *Favosites polymorpha*, Hamilton with *Spirifer mucronatus*, etc.

The granite boulders are often of large size, sometimes six feet and more in diameter, and generally rounded.

The largest transported blocks I have seen are the more or less angular masses of corniferous limestone mentioned on a preceding page.

Along the southern margin of the Drift area, especially on the slopes of the highlands of Northern Ohio, the Drift sands and gravels are of considerable thickness, forming hills of one hundred feet or more in height, generally stratified, but often without any visible arrangement. These deposits are very unevenly distributed, with a rolling surface frequently forming local basins, which hold the little lakelets or sphagnous marshes so characteristic of the region referred

to. These are the beds to which I have alluded as constituting, in the opinion of some geologists, a great glacial moraine, but from the fact that they are locally stratified, and overlie the older blue clays, I have regarded them as transported not by glaciers, but by icebergs.

Possibly some part of this Drift material may have accumulated along the margin of the great glacier, moved by its agency; but in that case we should expect to find in it abundant fragments of the rocks which outcrop in the region under consideration, whereas I have rarely, if ever, seen in these Drift gravels any representatives of the rocks underlying the south margin of the lake basin.

By whatever agency transported, the Drift gravels have, like the boulders, for the most part come from some remote point at the North, and were once spread broadcast along the southern shore of the inland iceberg-bearing sea.

In the retreat of the shore line during the contraction of the water surface down to its present area, every part of the slope of the southern shore between the present water surface and the highest lake level of former times, *i.e.* all within a vertical height of three hundred feet or more, must in turn have been submitted to the action of the shore waves, rain, and rivers, by which if, as is probable, the retrograde movement of the water line was slow, these loose materials would be rolled, ground, sorted, sifted, and shifted, so that comparatively little would be left in its original bedding; the fine materials, clay and sand, would be washed out and carried farther and still farther into the lake basin, and spread over the bottom, to form, in short, the upper sandy layers of the Drift.

At certain points in its descent the water level seems to have been for a time stationary, and such points are marked by terraces and the long lines of ancient beaches which have been referred to. A similar "lake ridge" now borders the south shore of Lake Michigan, where it may be observed in the process of formation; and this seems to be the legitimate

effect of waves everywhere on a sloping shore composed of loose material; storms driving up sand and gravel to form a ridge which ultimately acts as a barrier to the waves that built it. Winds, also, often assist in building up, and sometimes alone form these ridges, by transporting inland the beach sand.

In other localities, where hard rock masses formed the shore of our inland sea, perpendicular wave-worn cliffs were produced; and many of these now stand as enduring and indisputable monuments of a sea whose waves, perhaps for ages, beat against them. Such cliffs may be observed on Little Mountain, in Lake county, in the valley of the Cuyahoga, in Medina and Lorain county, Ohio, along the outcrops of the Carboniferous conglomerate and Waverly sandstone.

In all the changes through which the valley of the Mississippi passed during the "Drift Period," its general structure and main topographical features remained the same. Yet the character of its surface suffered very important modifications, and such as deeply affected its fitness for human occupation.

As we have seen, the glacial epoch was marked by erosion on a grand scale.

Then, our river valleys and some of our lakes — though mapped out long before — were excavated to a much greater depth than they now have.

During their subsequent submergence, these valleys and lakes were partially or perfectly filled with the drift deposits which covered all the surface like a deep fall of snow, rounded its outlines and softened all its asperities.

When the waters were withdrawn, the rivers again began clearing their obstructed channels; a work not yet accomplished, and in many instances not half done. Numbers of the old channels were wholly filled and obliterated, and the streams that once traversed them were compelled to find quarters elsewhere. Examples of this kind have been already cited, and they could be multiplied indefinitely.

ORIGIN OF THE GREAT LAKES. — The question of the origin of our lakes is one that requires more observation and study than have yet been given to it before we can be said to have solved all the problems it involves. There are, however, certain facts connected with the structure of the lake basins, and some deductions from these facts, which may be regarded as steps already taken toward the full understanding of the subject. These facts and deductions are briefly as follows: —

1st. Lake Superior lies in a synclinal trough, and its mode of formation therefore hardly admits of question, though its sides are deeply scored with ice-marks, and its form and area may have been somewhat modified by this agent.

2d. Lake Huron, Lake Michigan, Lake Erie, and Lake Ontario are excavated basins, wrought out of once continuous sheets of sedimentary strata by a mechanical agent, and that ice or water, or both.

That they have been filled with ice, and that this ice formed great moving glaciers we may consider proved. The west end of Lake Erie may be said to be carved out of the Corniferous limestone by ice action; as its bottom and sides and islands — horizontal, vertical, and even overhanging surfaces — are all furrowed by glacial grooves, which are parallel with the major axis of the lake.

All our great lakes are probably very ancient, as since the close of the Devonian period the area they occupy has never been submerged beneath the ocean, and their formation may have begun during the Coal Measure epoch.

The Laurentian belt, which stretches from Labrador to the Lake of the Woods, and thence northward to the Arctic sea, forms the oldest known portion of the earth's surface. The shores of this ancient continent, then high and mountainous, were washed by the Silurian sea, where the débris of the land was deposited in strata that subsequently rose to the surface, and formed a broad low margin to the central mountain belt, just as the Cretaceous and Tertiary strata flank the Alleghanies in the Southern States.

In the lapse of countless ages, all the mountain peaks and chains of the Laurentian continents have been removed and carried into the sea, and this has been done by rivers of water and rivers of ice. That these mountains once existed there can be no reasonable doubt, for their truncated bases remain as witnesses, and it is scarcely less certain that glaciers have flowed down their slopes of sufficient magnitude and reach to deeply score the plain which encircled them.

It will be noticed that all the great lakes of the continent hold certain relations to the curving belt of Laurentian highlands.

Some of them are embraced in the foldings of the Eozoic rocks, and fill synclinal troughs; but most of the series, from Great Bear Lake to Lake Ontario, exhibit the same geological and physical structure, are basins of excavation in the paleozoic plain that flanks in a parallel belt the Laurentian area. Few of us have any conception of the enormous general and local erosion which that plain has suffered. Those who will take the trouble to examine the section across Lake Ontario, from the Alleghanies to the Laurentian hills of Canada, and compare it with the other sections in the Lake Winnepeg district, radial to the Laurentian arch, given by Mr. Hind in his report on the Assiniboin country, will be sure to find the comparison interesting and suggestive; suggestive especially of a community of structure and history, and of an inseparable connection between the lake phenomena and the topographical features of the Laurentian highlands flanked by the paleozoic plain.

In estimating the influences that might have affected the number and magnitude of glaciers on the sides of the Laurentian mountains, it should not be forgotten that the Cretaceous sea swept the western shore of the Paleozoic and Laurentian continent from the Gulf of Mexico to the Arctic Ocean; and whether we consider this sea as a broad expanse of water simply dotted with islands, or a strait traversed by a tropical current, we have in either case conditions peculi-

arly favorable to the formation of great glacial masses of ice, *i. e.* a broad evaporating surface of warm water swept by westerly winds that carried all suspended moisture immediately on to a mountain belt, which served as a sufficient condenser.

This, at least, may be positively asserted in regard to the agency of ice in the excavation of the lake basins, that their bottoms and sides wherever exposed to observation, if composed of resistant materials, bear indisputable evidence of ice action, proving that these basins were filled by moving glaciers in the last ice period if never before, and that part, at least, of the erosion by which they were formed is due to these glaciers.

No other agent than glacial ice, as it seems to me is capable of excavating broad, deep, boat-shaped basins, like those which hold our lakes.

If the elevation of temperature and retreat northward of the glaciers of the lake basins were not uniform and continuous, but alternated with periods of repose, we should find these periods marked by excavated basins, each of which would serve to measure the reach of the glacier at the time of its formation, the lowest basin being the oldest, the others formed in succession afterwards. Such a cause would be sufficient to account for any local expansions of the troughs of the old ice rivers.

Where glaciers flow down from highlands on to a plain or into the sea, the excavating action of the ice mass must terminate somewhat abruptly in the formation of a basin-like cavity, beyond which would be a rim of rock, with whatever of débris the glacier has brought down to form a terminal moraine.

When glaciers reach the sea, the great weight of the ice mass must plough up the sea bottom out to the point where the greater gravity of water lifts the ice from its bed, and bears it away as an iceberg.

If it is true, as the facts I have cited indicate, that our

lakes are but portions of great excavated channels locally filled with drift material, the fiords of the northern Atlantic and Pacific coast present remarkable parallels to them; and I would suggest Puget's Sound, Hood's Canal, and other portions of that wonderful system of navigable channels about Vancouver's Island, as affording interesting and instructive subjects for comparison. Like our lakes their channels are for the most part excavated from sedimentary strata which form a low and comparatively level margin to the bases of mountain chains and peaks. They too have their depths and shallows, their basins and bars, and probably all who have seen them will assent to Professor Dana's view, that they are the "result of subaërial excavation," in which glaciers performed an important part.

The "Loess" of the Mississippi Valley. The "Bluff formation" of the West, sometimes called "Loess," from its resemblance to the Loess of the Rhine, I have on a preceding page designated as a lacustrine non-glacial Drift deposit. It seems to be the sediment precipitated from the waters of our great inland sea in its shallow and more quiet portions, to which icebergs, with their gravel and boulders, had no access, and where the glacial mud was represented only by an impalpable powder, which mingled with the wash of the adjacent land, land shells, etc.

It is evidently one of the most recent of the deposits which come into the series of Drift phenomena, and was apparently thrown down while the broad water surface which once stretched over the region where it is found was narrowing by drainage and evaporation, till, by its total disappearance, this sheet of calcareous mud was left.

It underlies much of the prairie region, and once filled, often to the brim, the troughs of the Mississippi and Missouri, so deeply excavated during the glacial epoch. When the system of drainage was re-established the new rivers began the excavation of their ancient valleys in the Loess. When they had cut into or through this stratum, so that it

stood up in escarpments on either side, man came and called it the *Bluff* formation, because it composed or capped the bold bluffs of the river-banks. It is often, however, only a facing to the rocky cliffs, which are the true walls of these valleys, and which are monuments of an age long anterior to the date of its deposition.—*Annals of the Lyceum of Natural History of New York*, 1869.

OUR NATIVE TREES AND SHRUBS.

BY REV. J. W. CHICKERING, JR.

It has long been a favorite aspiration of the writer, at some time in life, to have an arboretum collected from our woods and waysides. But despairing of that, I would in this article give a list of those native shrubs and trees, which seem to promise to repay transplanting, and which would in beauty, and many of them in novelty, to any but the botanist, vie with those imported.

Of the trees of early spring, it is a pity that the Silver Maple (*Acer dasycarpum*), and the Sugar Maple (*A. saccharinum*), were not more generally known and valued, as *flowering* trees. The former is the earliest tree I know in this latitude, and the beauty of the long, yellow tassels of the latter, commends itself to every observer. Then for grounds of any extent the different Birches, the White (*Betula alba*), the Paper (*B. papyracea*), the Yellow (*B. excelsa*), and the Black (*B. lenta*), are in early spring most attractive ornaments, for the grace and variety of the spray of their delicate catkins. Then the Tulip Tree (*Liriodendron tulipifera*), and the Cucumber Tree (*Magnolia acuminata*), both perfectly hardy in New York and New England, should be seen much more frequently in cultivated grounds.

The Barberry (*Berberis vulgaris*) forms a pleasing clump

whether it hang out its bright yellow flowers or its crimson berries.

Of course the Sumachs would claim a place with their variety of flower, fruit and leaf, at least the Staghorn Sumach (*Rhus typhina*), with its red velvety branches; *R. glabra*, as smooth as the last is shaggy, and *R. copallina*, with its leaves looking as if varnished.

The New Jersey Tea (*Ceanothus Americanus*), with its spikes of delicate white flowers, demands a place, as well as admiration.

Bittersweet (*Celastrus scandens*), also called Roxbury Waxwork, so well known as having given a name to one of the most charming rural poems in our language, is a hardy climber, vigorous and luxuriant in summer, and very conspicuous in autumn, with its scarlet seed coverings set in orange linings, as is its first cousin the Waahoo (*Euonymus atropurpureus*), with its crimson drooping fruit, not uncommon in cultivation.

The Red-bud, or Judas Tree (*Cercis Canadensis*), with its branches all aflame in early spring, is a small, graceful tree.

Spiræa opulifolia, is an attractive variety, while the Meadow Sweet (*S. salicifolia*), and the Hardhack (*S. tomentosa*), so valuable as a medicine, were they only less common, would be eagerly sought for their beauty.

The Shad-bush (*Amelanchier Canadensis*), heralding along the Connecticut, "the first run of shad," is a favorite where-ever known, while the Witch Hazel (*Hamamelis Virginica*), closing the floral procession of the season with its weird, wrinkled yellow flowers in October, and even November, is not to be neglected.

The Flowering Dogwood (*Cornus florida*), beautiful alike in its snowy profusion of flowers and its bright red berries, is less known and far less cultivated than its merits deserve. It is hardy, with bright green leaves, and ought to become common, as our most showy shrub or small tree.

Several other species of this genus are worthy a place in our collections: *Cornus circinata*, *sericea*, *stolonifera*, *paniculata*, *alternifolia*, all of which may be found either in thickets or swampy places.

The Honeysuckle family is already introduced, but some members of it need a special introduction.

The Snowberry (*Symphoricarpus racemosus*), with its fruit so well known to children as far from liability to stain; and the Coral-berry (*S. vulgaris*), are in general cultivation, especially the former.

The Trumpet Honeysuckle (*Lonicera semperivirens*), and the delicate little Fly Honeysuckles (*L. ciliata* and *cœrulea*), are equally as charming as some of their foreign sisters. The *Viburnum* too is a beautiful genus. The Cranberry Tree (*V. Opulus*), whose fruit is better to look at than to eat, and the Hobble-bush (*V. lantanoides*), so called from the facility with which its procumbent branches trip the incautious traveller, are well known in early spring, with their broad cymes of mainly sterile flowers; and the flower-buds of the latter forming in early autumn, afford a beautiful study of nature's care in affording protection against the winter's cold; while the rusty down upon the leaf-stalks affords under the microscope a most beautiful specimen of stellate hairs. But the other species, *V. nudum*, *prunifolium*, *dentatum*, *pubescens*, *acerifolium*, and especially *Lentago*, while by no means rare in the woods and copses, are very beautiful, with enough of variety to render it desirable to have them all.

The Button-bush (*Cephalanthus occidentalis*) is odd, with its buttons of white flowers, and worthy of cultivation.

Many of the *Ericacæ* are no less beautiful than unknown. The Swamp Blueberry (*Vaccinium corymbosum*) with its great variety of forms, is a very attractive shrub, with pubescent leaves, large flowers, and conspicuous and delicious fruit. The Deerberry (*V. stamineum*) is very peculiar in its habit of flowering, and would be very ornamental. Doubt-

less this genus will eventually be taken up by the nurserymen, as have the different species of Rubus.

The Leather Leaf (*Cassandra calyculata*), and *Andromeda polifolia*, are both worthy of attention. White Alder (*Clethra alnifolia*) is already somewhat known, and is covered in August with handsome blossoms so fragrant that a clump may be detected at many rods distance.

Mountain Laurel, Calico-bush, Spoon-wood (*Kalmia latifolia*), is one of the most beautiful shrubs ever created, as seen in profusion in its varying shades, in parts of Massachusetts, but very seldom in cultivation. *Kalmia glauca*, or Pale Laurel, is less showy, but of great beauty. The Azaleas (*A. viscosa* and *nudiflora*) are very common, very beautiful and fragrant, but very seldom cultivated.

The Great Laurel (*Rhododendron maximum*), though magnificent in its native thickets, cannot probably compete with the foreign species, now so generally introduced, but *Rhodora Canadensis*, with its rose-purple blossoms, covering the leafless branches, is one of the pleasantest sights of early spring, and Labrador Tea (*Ledum latifolium*) with its delicate white clusters and leaves rusty-woolly beneath, is likewise full of beauty.

The Fringe-tree (*Chionanthus Virginica*) with its delicate white drooping panicles, ought to be seen much more frequently than it is.

Sassafras officicinale with its curiously lobed leaves, yellow racemes of flowers, and spicy aroma; Leather-wood (*Dirca palustris*), also called Wicopy, with pale yellowish flowers is a curious shrub, its wood soft and brittle, its bark so tough that it can be used for thongs, requiring a strong man to break even its slenderest twigs.

From this list have been omitted very many trees and shrubs in common cultivation. The object has been to call attention to those less generally known. Many of these have their natural station in swampy ground; many resist attempts at transplanting. But a little care in choosing from

those in dryer locations, or setting out in moist ground, or better yet, propagating from seed, would doubtless overcome these difficulties, reward the pains taken, and introduce some charming novelties to the lovers of flowers.

Such an arboretum, shrubbery or lawn, comprising only native species, would not only gratify the botanist and the naturalist, but would surprise and delight the rapidly increasing number of amateur cultivators, who as yet have very little idea of the wealth of floral beauty to be found in our swamps and woodlands.

A WINTER'S DAY IN THE YUKON TERRITORY.

BY W. H. DALL.

MANY of the readers of the NATURALIST when they hear Alaska spoken of, picture to themselves a snow-covered country, with at most a scanty summer, and a long and extremely cold winter. A recent "official" report for instance, represents the island of St. Paul as surrounded in winter by "immense masses of ice" on which the polar bears and arctic foxes sail down from the North and engage in pitched battle with the wretched inhabitants. Such romances are due solely to the ardent imagination of the "official" mind, and have no basis in fact. There is no solid, and but little floating ice near St. Paul in winter; the arctic foxes found there as well as on most of the other islands, were purposely introduced by the Russians for propagation, a certain number of skins being taken annually; and finally, we have no authentic evidence that the polar bear has ever been found south of Behring Strait.

The country of Alaska comprises two climatic regions which differ as widely as Labrador and South Carolina in their winter temperature. One contains the mainland north

of the peninsula of Aliaska and the islands north of the St. Matthew group. The other includes the coast and islands south and east of Kadiak, while the Aleutian Islands, with the group of St. Paul and St. George, are somewhat intermediate, being nearly as warm as the southern or Sitkan district, and much less rainy.

This article will refer only to the northern district, which I have called the Yukon Territory. This is the coldest and most inhospitable part of the country, yet it is far from resembling Labrador or Greenland, although the winter weather may occasionally be very cold. The summers are much warmer and more pleasant than in Labrador, and may be compared to those of the Red River district of the Hudson Bay Territory.

At the first thought one would hardly suppose that a naturalist would find much to do in the depth of winter, unless it were to sit by his great Russian oven or stove, and keep himself warm. I would invite the readers of the NATURALIST to accompany me on a day's tramp, similar to many which I have undertaken without such pleasant company, and see how far their first anticipations will be realized.

We will start from Ulokuk, an Indian village on the portage between the Yukon and Norton Sound, and bring up at Unaloklik, an Eskimo village on the coast, thirty miles away.

We clothe ourselves in the comfortable costume of the country, consisting of a pair of warm American trousers; a deerskin hunting shirt with a hood, made with the hair on, trimmed with wolf or wolverine skin, and fastened by a belt around the waist; a good mink-skin cap with ear-lappets; a pair of otter-skin mittens; and a pair of long Indian deerskin boots with soles of sealskin, tied around the ankle and just below the knee, and having a bunch of straw below the foot to keep it warm, dry, and safe from contusions. Our equipment will consist of our guns, a geological hammer, a good sheath-knife, a small axe, teakettle, bag of biscuit and dry salmon, and a pair of long snowshoes apiece.

We start at ten o'clock, just as the December sun emerges from the southern hills and casts its welcome beams over the broad tundra covered with snow, flecking the green spruce boughs with golden touches of light, and giving a mellow tone to the clear blue sky. The temperature may be about twenty below zero, but in our warm deerskin dresses, we feel that it is only just cold enough to make the blood leap and the nerves thrill with the excitement of a brisk walk, skimming over the snow with our light snowshoes.

We just clear the alder bushes around the village when a chirp and twitter in a clump of willows attract our attention. We look, and see a flock of the Pine Grosbeaks (*Pinicola enucleator*), brilliant in scarlet and yellow, rifling the willows of their buds, carefully rejecting the scales and eating only the tender green hearts of the young buds. They look so pretty as they ruffle their scarlet coats, defying the winter frost, fat and comfortable with abundance of food, that we hesitate before we bring our guns to bear on them, and reluctantly add half a dozen members of the happy family to our collecting bag, with a single shot. They have the large bill which has been thought to distinguish the European form alone, and cannot be distinguished from typical specimens of the *enucleator*. They are among the most common of the Yukon birds in winter, and though quite small are usually fat and tender, and not to be despised in a pie. Leaving the banks of the Ulokuk River we strike across an undulating prairie called *tundra* by the Russians, and only marked by clumps of dwarf willow (*Salix Richardsonii*), which project above the snow. Here and there a larch shakes its myriads of little cones in the passing breeze, or a small spruce shows its green tips; but the large spruce, poplar, willow and birch, prefer the vicinity of the river. The snow-covered Ulokuk Hills smooth, serene and beautiful, bear up the reluctant sun, which seems loth to part from the horizon. Does the snow move? or what is that by yonder willow brush? We are answered as a covey of the exquisite

Snow Grouse or Ptarmigan (*Lagopus albus*) rise with a whirr, showing their black tail-feathers as they seek a more retired spot. Scarcely to be distinguished from the snow, nor less immaculate, we must be more sharply on the lookout if we would secure a brace next time. They are better to look at than to eat; for the dark colored flesh is dry and tasteless, and if we want specimens the better plan is to apply to the next Indian girl we meet. She, for a needle apiece, will furnish us with birds caught in snares, without a feather ruffled, or a speck on their shining coats. Their legs and feet are feathered down to the toes, and other stockings would be superfluous were we ourselves so warmly clad.

As we near a clump of poplars on a bend in the river, we see that the bushes are alive with tiny birds. The Black Cap (*Parus atricapillus*) and the Hudson Bay Titmouse (*P. Hudsonicus*), chatter to each other from the swaying twigs of alder, and a little farther on is a countless flock of the Rosy Crowned Sparrow (*Ægiothus linaria*) bold and saucy, with their crimson crests and rosy bosoms setting off their graceful shapes and lively motions.

Chip! chip! chee! cries an angry Squirrel (*Sciurus Hudsonius*) from yonder poplar; he evidently wants to know why we intrude on his privacy with guns and things, making ourselves disagreeable. A look, and he darts behind the trunk, only showing his head and ears, repeating his angry cry in apparent astonishment at our obstinacy in remaining. Finding us unmoved "a change comes o'er the spirit of his dreams" and he seeks refuge in the deserted nest of a Golden-winged Woodpecker (*Colaptes auratus*), and waits for better times. You ask what is yonder broad trail in the snow; too small for a bear, too broad and heavy for a fox. It is the track of a Wolverine (*Gulo luscus*), known here by the more euphonic name of *rossamorga*. The Indians tell strange stories of his cunning, his perseverence in destroying their traps, and his almost human powers of reflection. The

Hudson Bay men say the same, but between you and I, I don't believe half of it. Mr. Carcajoû is very intelligent, no doubt, but he takes the place of snakes in the legends of the northern trapper, and we all know what stories are told about snakes, in more southern latitudes.

The sun, though very low, is at his noonday elevation, and a short time will be devoted with satisfaction to lunch. One takes the axe and starts for a dead dry spruce tree, another scrapes away the snow from a hillock, with his snowshoe. There we see in the depth of winter bright green mosses and other small plants, with the partridge berry and cranberry vines loaded with berries beneath the snow. The white fleecy covering defends them from the frost, and when the snow melts in the spring they have only to put forth their blossoms and continue to grow, under the warm sun which endures almost till midnight in May and June.

Here comes the wood, and we proceed to make a white man's fire, which is built with the sticks laid parallel in layers which are at right angles to one another. This makes a flat top, and taking a dry stick we whittle a few shavings, which are put on top of the pile. Then with a flint and steel (for matches are luxuries in the Yukon Territory) we light a bit of punk, and with our breath as a bellows, in a few moments we have a light with which we proceed to kindle the fire, putting it on top of the pile, so that the air having free access, it soon produces a cheerful blaze. An Indian builds his fire conically, which is much less convenient and takes much longer to boil the kettle. It is a work of time and difficulty to melt enough snow to fill the teakettle, and taking the axe, we go yonder where a low, smooth depression in the snow indicates the position of what was a pool of water. A few minutes vigorous chopping and the welcome fluid gushes up and rapidly overflows the surface of the ice where we have scraped away the snow. It is full of little red crustaceans, like sand fleas, etc., among which we may distinguish members of the genus Cyclops, giants of their

kind, carrying two pear-shaped bunches of eggs, one on each side of the tail. We throw a double handful of snow into the hole to filter out these unbidden guests, and filling the teakettle return to the bivouac where the others are broiling pieces of dry salmon on sticks by the fire. As soon as the kettle boils we put in the tea and let it boil up once, and our meal is ready. Tin cups in hand, we enjoy the grateful and refreshing beverage, which is worth more to the traveller in the north than any amount of whiskey. Indeed the latter is worse than worthless, and no old traveller would wish to have it along with him. After tea, biscuit and salmon are discussed, the one other luxury of voyageur life is enjoyed, namely, a cheerful pipe of tobacco, and replacing our pipes in our "fire-bags" we continue on our way. By keeping a sharp lookout it is more than probable that we shall see a Marten (*Mustela Americana*) seeking refuge in some bushy spruce as we pass by. Their tracks are everywhere, and they often disturb the traveller's cache of dry salmon used for dog feed, and left by the roadside until his return.

We keep on our way through thick spruce groves where the trees may average eighteen inches in diameter and forty feet high. In the interior, on the Yukon, they grow much larger, but all the trees diminish in size and abundance as we approach the coast, where there are none at all. The Aspen (*Populus tremuloides*), the Spruce (*Abies alba*), the Poplar (*Populus balsamifera*), and the Birch (*Betula glandulosa*), are the largest and most prominent trees. There are no true pines, though the settlers call the spruce "pine." Leaving the bank as we reach the river we continue on our way upon the ice. Although the thermometer may have been as low as fifty below zero since August, yet you will always find open places in the ice. These are formed by the rapid current or by warm springs. At Ulokuk there are a number of the latter, which keep a large space in the river open all the year round. Over this water a cloud, like steam, arises

in very cold weather. Myriads of fish, particularly a delicious salmon-trout, and a small cyprinoid fish, frequent such localities. One would hardly look for insects in this winter weather, yet by watching the snow on the river while the sun shines brightly, a small, shining, pointed creature, like a *Podura*, may be seen gliding between the particles of snow, and immediately disappearing should a cloud pass over the sun. In September I have found wooly caterpillars, the larvæ of *arctians*, crawling on the snow, while the atmosphere was even below zero; and I once found (October 20th) the caterpillar of *Vanessa Antiopa* in the same manner, alive; and on yet another occasion I shot a whiskey jack, or Canada jay (*Perisoreus Canadensis*), with one just killed, in his mouth. A little way farther on, a bluff of dark colored sandstone fronts the river. Here our hammers may well be employed, and with care fine specimens of fossil leaves may be obtained. These are usually Sycamores (*Platanus*), but others can be found by searching for them, and in Cook's Inlet some fifty species have been collected, some of which are common to Greenland, Spitzbergen, Northern Europe and Siberia, showing that there was a time when this part of the world was covered with a rich and verdant forest, and the temperature was about that of Virginia. This was before the advent of the hairy elephant, who lived in colder times. It grew at last too cold for him, however, and his bones and teeth may be found scattered over the country, on the surface, and usually much decayed. His remains have been found imbedded in the masses of ice (not glaciers) which fringe the Siberian coasts, and in a perfect state of preservation, as if he had wandered into an enormous refrigerator and been frozen into it.

You will look in vain here for the familiar drift boulders, so common in the stone fences of New England. What was going on during the glacial period in the Yukon Territory is a mystery. There were no glaciers there, for their traces are entirely wanting.

The sun is now on the point of retiring for the night, although it is barely three o'clock, and the sight of the tall caches, like corncribs, which mark the position of the village for which we are bound, is not unwelcome; for thirty miles on snowshoes is a good day's tramp, especially for the first time. In a few minutes we are seated in one of the comfortable underground houses and enjoying the hospitality of the friendly Eskimo. Perhaps some summer's day, reader, we will try our luck together again.

A FEW WORDS ABOUT MOTHS.

BY A. S. PACKARD, JR.

THE opportunity of copying a number of colored figures by Abbot, hitherto unpublished, leads me to say a few words regarding our native moths. The Lepidoptera, both butterflies and moths (especially the former, from their constant presence by day) from their beauty and grace, have always been the favorites among amateur entomologists, and the rarest and most costly works have been published in which their forms and gorgeous colors are represented in the best style of natural history art. We need only mention the folio volume of Madam Merian of the last century, Harris's Aurelian, the works of Cramer, Stoll, Drury, Hübner, Horsfield, Doubleday and Westwood, and several others, as comprising the most luxurious and costly entomological works.

Near the close of the last century, John Abbot went from London and spent several years in Georgia, rearing the larger and more showy butterflies and moths, and painting them in the larva, chrysalis and adult, or imago, stage. These drawings he sent to London to be sold. Many of them were collected by Sir James Edward Smith, and published under the title of "The Natural History of the Rarer Lepi-

dopterous Insects of Georgia, collected from the Observations of John Abbot, with the Plants on which they Feed." London, 1797. 2 vols., fol. Besides these two rare volumes there are sixteen folio volumes of drawings by Abbot in the Library of the British Museum. The plate given with this article is selected from a thick folio volume of similar drawings presented by Dr. J. E. Gray of the British Museum to Professor Asa Gray, to whose kindness we are indebted for an opportunity of figuring the transformations before unknown of over a dozen moths, whose names are given, as far as possible in the present state of our knowledge, in the explanation of the plate.

The study of insects possesses most of its interest when we observe their habits and transformations. Caterpillars are always to be found, and with a little practice are easy to raise, and we would advise any one desirous of beginning the study of insects to take up the butterflies and moths. They are perhaps easier to study than any other group of insects, and are more ornamental in the cabinet. As a scientific study we would recommend it to ladies as next to botany in interest and the ease in which specimens may be collected and examined. The example of Madam Merian, and several ladies in this country who have greatly aided science by their well filled cabinets, and thorough and critical knowledge of the various species and their transformations, is an earnest of what may be expected from their followers. Though the moths are easy to study compared with the bees, flies, beetles and bugs, and neuroptera, yet many questions of great interest in philosophical entomology have been answered by our knowledge of their structure and mode of growth. The great works of Herold on the evolution of a caterpillar; of Lyonet on the anatomy of the Cossus; of Newport on that of the Sphinx, both in their various stages; and of Siebold on the parthenogenesis of insects, especially of *Psyche helix*, are proofs that the moths have engaged some of the master minds in science.

The study of the transformations of the moths is also of great importance to one who would acquaint himself with the questions concerning the growth and metamorphosis and origin of animals. We should remember that the very words "metamorphosis" and "transformation," now so generally applied to other groups of animals and used in philosophical botany, were first suggested by those who observed that the moth and butterfly attain their maturity only by passing through wonderful changes of form and modes of life.

The knowledge of the fact that all animals pass through some sort of a metamorphosis is very recent in physiology. Moreover the fact that these morphological eras in the life of an individual animal accord most unerringly with the gradation of forms in the type of which it is a member, was the discovery of the eminent physiologist Von Baer. Up to this time the true significance of the luxuriance and diversity of larval forms had never seriously engaged the attention of systematists in entomology.

What can possibly be the meaning of all this putting on and taking off of caterpillar habilaments, or in other words, the process of moulting, with the frequent changes in ornamentation, and the seeming fastidiousness and queer fancies and strange conceits of these young and giddy insects seem hidden and mysterious to human observation. Indeed, few care to spend the time and trouble necessary to observe the insect through its transformations; and that done, if only the larva of the perfect insect can be identified and its form sketched how much was gained! A truthful and circumstantial biography in all its relations of a single insect has yet to be written.

We should also apply our knowledge of the larval forms of insects to the details of their classification into families and genera, constantly collating our knowledge of the early stages with the structural relations that accompany them in the perfect state.

The simple form of the caterpillar seems to be a concen-

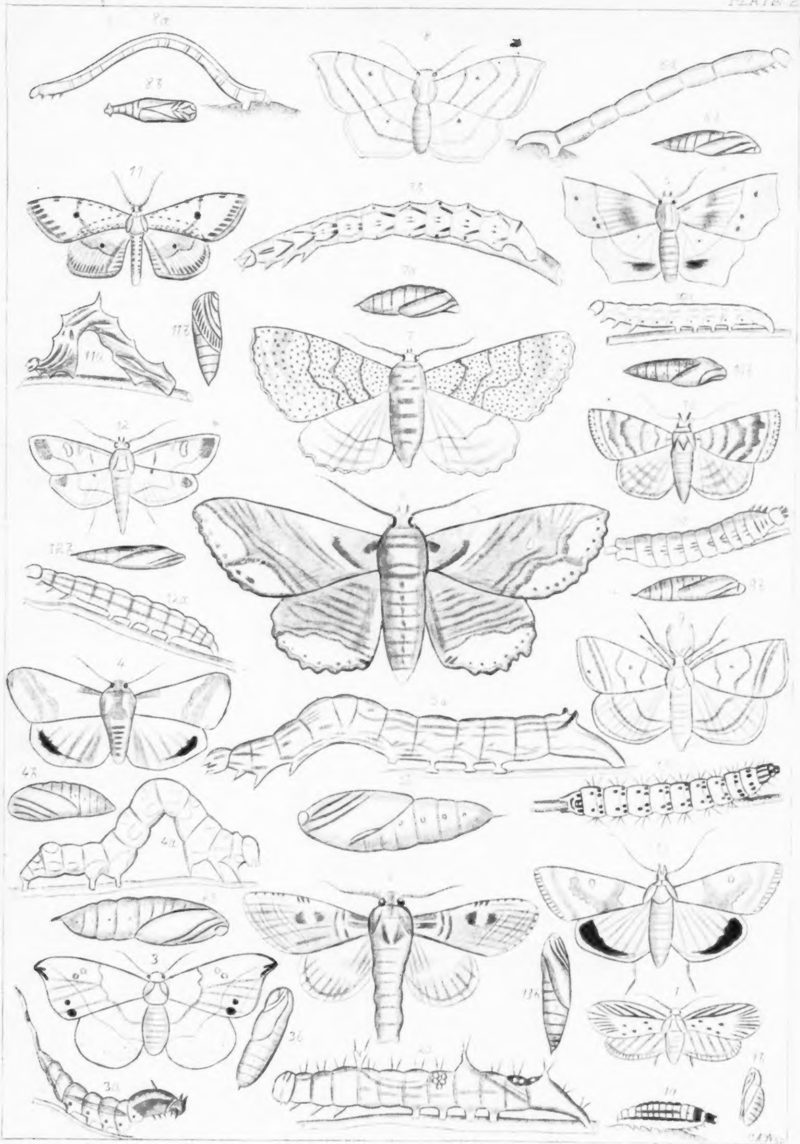
tration of the characters of the perfect insect, and presents easy characters by which to distinguish the minor groups; and the relative rank of the higher divisions will only be definitely settled when their forms and methods of transformation are thoroughly known. Thus, for example, in two groups of the large Attacus-like moths, which are so amply illustrated in Dr. Harris's "Treatise on Insects Injurious to Vegetation;" if we take the different forms of the caterpillars of the Tau moth of Europe, which are figured by Godart and Duponchel, we find that the very young larva has four horn-like processes on the front, and four on the back part of the body. The full grown larva of the Regalis moth, of the Southern states, is very similarly ornamented. It is an embryonic form, and therefore inferior in rank to the Tau moth. Multiply these horns over the surface of the body, lessen their size, and crown them with hairs, and we have our Io moth, so destructive to corn. Now take off the hairs, elongating and thinning out the tubercles, and make up the loss by the increased size of the worm, and we have the caterpillar of our common Cecropia moth. Again, remove the naked tubercles almost wholly, smooth off the surface of the body, and contract its length, thus giving a greater convexity and angularity to the rings, and we have before us the larva of the stately Luna moth that tops this royal family. Here are certain criteria for placing these insects before our minds in the order that nature has placed them. We have here certain facts for determining which of these three insects is highest and which lowest in the scale, when we see the larva of the Luna moth throwing off successively the Io and Cecropia forms to take on its own higher features. So that there is a meaning in all this shifting of insect toggery.

This is but an example of the many ways in which both pleasure and mental profit may be realized from the thoughtful study of caterpillar life.

In collecting butterflies and moths for cabinet specimens, one needs a gauze net a foot and half deep, with the wire

—THE—
JOHN CRERAR
LIBRARY

PLATE 2.



frame a foot in diameter; a bottle containing a parcel of cyanide of potassium gummed on the side, in which to kill the moths, which should at once be pinned in a cork-lined collecting box carried in the coat pocket. The captures should be spread and dried on a grooved setting board, and a cabinet formed of cork-lined boxes or drawers; or as a substitute for cork, frames with paper tightly stretched over them may be used, or corn, or palm-pith. Caterpillars should be preserved in spirits, or glycerine with a little spirits, or strong salt and water, while some ingeniously empty the skins and inflate them over a flame so that they may be pinned by the side of the adult.

EXPLANATION OF PLATE 2.

Fig. 1. *Eustixis pupula* Hübner, female; 1*a*, larva, 1*b*, pupa. Feeds on *Sideronytum tenax.*

Fig. 2. *Cœlodasys biguttatus* Pack., male; 2*a*, larva; 3*a*, pupa. Feeds on *Ipomea coccinea.*

Fig. 3. *Dryopteris*, probably undescribed, female; 3*a*, larva; 3*b*, pupa. Feeds on *Viburnum nudum.*

Fig. 4. *Acontia metallica* Grote, male; 4*a*, larva; 4*b*, pupa. Feeds on *Hibiscus palustris.*

Fig. 5. *Homoptera edusa* (Drury). 5*a*, larva; 5*b*, pupa. The plant on which it feeds is not named.

Fig. 6. *Hyperetis*, species not known, female; 6*a*, larva; 6*b*, pupa. Feeds on a species of *Azalea.*

Fig. 7. *Boarmia*, species not known, female; 7*b*, larva; 7*a*, pupa. Feeds on *Helenium.*

Fig. 8. *Acidalia*, species unknown. 8*a*, larva; 8*b*, pupa. Feeds on *Trillium.*

Fig. 9. *Herminia*, species not identified, male; 9*a*, larva; 9*b*, pupa. Feeds on *Rhexia mariana.*

Fig. 10. *Helia æmulalis* (Hübner)? female; 10*a*, larva; 10*b*, pupa. Feeds on *Phlox speciosa.*

Fig. 11. An unknown species of *Phalænidæ*, male; 11*a*, larva; 11*b*, pupa. Feeds on *Coreopsis.*

Fig. 12. A species of *Botys*, male; 12*a*, larva; 12*b*, pupa. Feeds on *Ipomea.*

Fig. 13. A species of *Botys*, female; 13*a*, larva; 13*b*, pupa. Feeds on a species of *Crotalaria.*

REVIEWS.

Modern Ideas of Derivation.* — This felicitous title heads an equally expressive and concise summary of the various theories on the origin of species, treated by the strong hand of an accomplished and veteran observer.

Professor Dawson recognizes that Darwin has given form and coherency to researches upon the origin of species, but omits one very important consideration, to which we think the greatest effect of his book is due. The novel and exact methods of investigation, the analytical character of the book powerfully influenced a much larger class of minds than those who heartily accepted the theory of a struggle for existence. The doctrine of natural selection may or may not be true, but the mode of study which it inaugurated began a new era in the history of natural sciences and is already producing results of great value.

The author begins his review with Professor Owen, but succeeds no better than his predecessors in the same field, and is forced finally to deduce his opinions from the oracular manner in which that distinguished anatomist writes of certain animals as being "made," "formed," or "brought forth." Professor Huxley gets a well deserved and very sarcastic notice for his late attempt to prove the theory of derivation by "a series of cleverly arranged transitions," between some of the larger fossil reptiles (Iguanodons) and the ostriches. "Yet," writes Professor Dawson, "he could not have placed together any two members of the supposed series without convincing any naturalist that an enormous gap had to be filled between them." The views of Darwin are summed up as follows: "That all organized beings are engaged in a struggle for existence; that in this struggle certain varieties arise, which, being better suited to the conditions, prosper and multiply more than others: that this amounts to a 'Natural Selection,' similar in kind to the artificial selection of breeders of stock; that members of the same species isolated from each other and subjected to struggles of different kinds, will in process of time become specifically distinct."

Professor Dawson objects to this theory for several reasons. The most important are that "conditions which involve a struggle for existence are found by experience to result in deterioration and final extinction rather than improvement, and are directly opposed to those employed by breeders for their purposes," and that the possibilities of geological history are exceeded by the enormous time demanded by Darwin for accomplishing the developmental change from one species to another.

Seemingly no worse or more contradictory comparison could be made

* Modern Ideas of Derivation. By Principal J. W. Dawson, LL. D. Canadian Naturalist, Vol. iv, No. 2. June, 1869.

than that between the laws which govern the transmission of characteristics among races perpetually clashing in the "struggle for existence," and those influencing the production of different breeds among animals enjoying the protection of the animal breeder. We, however, think that Professor Dawson would find it difficult to establish the truth of this very important proposition, that the conditions involving a struggle for existence necessarily lead to extinction. Darwin himself has shown that it leads to the extinction of those races which are not possessed of certain advantages, and that it cannot according to physiological laws do otherwise than develop in a higher degree those points or changes in the favored races which enabled them to gain their first victories over their weaker brothers.

The last objection, with regard to the lapse of time demanded for specific changes according to the Darwinian theory, is becoming stronger every day. Deep sea dredgings have shown us that computations of geological time, based upon the thickness of rocks, and the presence of different assemblages of animals or faunæ in successive beds are not to be relied upon. These explorations have detected the presence of very distinct faunæ dependent upon changes of temperature, and very different rocks in the course of formation within comparatively narrow limits. Thus it no longer becomes necessary to account for the change from one fossil fauna to another, as we pass from one stratum or bed to another in geological time, by imagining the lapse of ages and a corresponding modification of the organization of the animals included in the lowest bed. A simple change of fourteen degrees Fahrenheit may possibly make the difference between a limestone composed entirely of organic remains, and a sandstone containing the fossil remnants of a totally distinct fauna, though both of these may have been composed of contemporaneous animals.*

The author's remarks upon Professor Cope's late paper before the American Association so well expresses the substance of the new theory of derivation that we quote them in full:

"The last of these hypotheses which I shall notice, and, in my view, the most promising of them all, is one which has recently been ably advocated by Mr. Edward D. Cope in a memoir on the 'Origin of Genera,' published in the Proceedings of the Academy of Natural Sciences,† and which is based on the well known analogy between embryonic changes, rank in the zoological scale and geological succession. It may be illustrated by the remarkable and somewhat startling fact, that while no authenticated case exists of animals changing from one species to another, they are known to change from one genus or family to another, and this without losing their individuality. Professor Dumeril, of Paris, and Professor Marsh, of New Haven, have recently directed attention to the fact that species of *Siredon*, reptiles of the lakes of the Rocky Mountains of Mexico, and which, like our North American *Menobranchus*, retain their gills during life, when kept in captivity in a warmer temperature than that which is natural to them, lose their gills, and pass into a form hitherto regarded as of a different genus and family,—the genus *Amblystoma*. In this case we may either suppose that the Amblystoma, under unfavorable circumstances, has its maturity and reproduction prematurely induced be-

*See Recent Explorations of Deep Sea Fauna, by A. E. Verrill. American Journal of Science and Art, 2d series, January, 1870.

†Philadelphia, 1869.

fore it has lost its gills, or that the Siredon has, under certain circumstances the capacity to have its period of reproduction arrested until it has gone on a stage farther in growth and has lost its gills. In any case the same species—nay, the same individual—is capable of existing in a state of maturity as a creature half fish and half reptile in regard to its circulation, or in a more perfect reptilian state in which it breathes solely by lungs. Farther, we may suppose conditions of the earth's surface in which there would only be Siredons or only Amblystomas, and a change in these conditions inducing the opposite state. Here we have for the first time actual facts on which to base a theory of development. These facts point to the operation of two causes—first, the possible *Retardation* or *Acceleration* of development, and secondly, the action of outward circumstances on the organism capable of this retardation or acceleration. We here substitute for the tendency to vary of Owen's theory, the ascertained fact of reproductive retardation or acceleration, and for the struggle for existence, the action of changed physical conditions, and for the question as to the change of one species into another, the change of the same species from one genus into another. Farther, instead of vague speculations as to possible changes of allied animals, we are led to careful consideration of the embryonic changes of the individual animal, and as to the differences that would obtain were its development accelerated or retarded. We can thus range animals in genetic series within which anatomical characters would show change to be possible. I cannot follow these series out into the elaborate lists tabulated by Mr. Cope, but may proceed to notice the limitations which his views put to the doctrine of derivation. It is obvious that, if this be the real nature of derivation as a possible hypothesis, then derivation must follow the same law with metamorphism and embryonic development.

According to this view, also, a species once created may have in itself a capacity for passing through several generic forms, constituting a cycle which ever tends to return into itself, or to advance and recede by steps more or less abrupt under the law of retardation and acceleration, combined with the influence of external circumstances. Yet the dimensions of the orbit of each species must be limited, its duration in time must also be limited, and its capacity to pass into a really new species must still be a point subject to doubt, but open to anatomical investigation and inference. As already hinted, it is a most important point of this theory, that when we have ascertained the series of embryonic changes of any animal, we have thereby ascertained its possibilities in regard to accelerated development. Its possibilities in regard to retarded development may be inferred by similar studies of animals higher in the scale. Now, if we knew the embryonic history of every animal, recent and fossil, in its anatomical details, we should be able to construct out of this a table of possible affiliation of animals, and should be able to trace our existing species through the same genera, families, orders and classes in which they might have existed in geological time, and to predict what they might become in time still to come."

This theory of acceleration we have also shown to be the law of growth* among the Nautiloids and Ammonoids. Thus the discoidal Nautili, though an ancient group, do not accomplish during their entire life, from the Silurian to the Tertiary, such extensive changes in the septa as the Clymeniæ do in the course of a single geological epoch, the Devonian. Each species of this group adds something to the serial complication of the lobes and cells of the sutures until from a species *Clymenia lævigata*, inseparable generically from the Nautiloids, there is produced a species, *Clymenia pseudogoniatites*, which is a true Ammonoid.

This last species presenting itself to the geologist suddenly according to the usual action of the law of acceleration, has young with lateral lobes, and an internal siphon like the other Clymeniæ, but both the young and adult have the abdominal lobes and superior lateral cells of an Ammonoid, as well as the more involute whorls of that order. This case is precisely parallel to that of the growth of the Siredon salamander into

*On the Parallelism between the Different Stages of Life in the Individual and those in the entire Group of the Molluscus Order, Tetrabranchiata. By A. Hyatt. Memoirs Boston Society of Natural History, Vol. 1, Part 2, 1867.

an Amblystoma, and presents itself to the geologist when compared to the lower Clymeniæ in the same way, the only difference being that in this case the characteristics of a different order of animals are produced by the acceleration of the growth, instead of a distinct family and genus merely.

Other instances are brought forward in the memoir referred to above which show the action of the law of acceleration, when applied to different species, and since then other observations have been made which demonstrate with equal clearness the agency of the law of acceleration in the production of varieties and even of individual differences.

Thus one of the best known species of the Lower Lias, *Asteroceras* (Ammonites) *obtusum*, is divisible into several varieties. For the sake, however, of reducing it as much as possible we will eliminate all of these but three, and consider only the English specimens from one locality, Lyme Regis. These have three distinct variations of form. The first has the ordinary rounded sides and abdomen, with very broad immature keel and exceedingly shallow channels, while the *pilæ* (costæ) are prominent and round off evenly at either end. The channels appear on the last quarter of the third, and almost immediately attain their ultimate adult depth and aspect on the fourth volution; the second has the same peculiarities in the larger number of individuals, but accelerates them by adding to the depth of the channels and the height of the keel after the fourth volution, producing thereby adults with deeper channels and more prominent keels. There are different degrees of this acceleration in different individuals, some having shallower channels than others.

The third variety attains the adult characteristics of the most advanced members of the second variety on the fourth whorl, and on the fifth, flattens the sides. The first and second varieties have gibbous or rounded sides, but the third is a transitional variety, approximating to *Asteroceras stellare*. The accelerations show themselves also in the development of the pilæ; the second variety ceasing to be smooth and beginning to form these lateral projections at an earlier age than the first, and the latter forms the same parts at an earlier age than in the first variety.

This whole progress in the form and characteristics of parts takes place by individual accelerations. Thus in the first variety we have certain individuals which remain smooth longer than others which nearly equal the rate of growth observable in the second variety, but are retained in the first by the slower development of the keel and channels. An objection may and probably will be made to this view, that the third is really a variety of *Asteroceras stellare*, and does not belong to *Asteroceras obtusum* at all. This alternative would be even more favorable to the theory here advanced than that given above. The difference is less in all respects between the third variety described above and the unquestionable *Asteroceras obtusum*, than between the former and *Asteroceras stellare*. Therefore any estimation of the value of their characteristics which would join the third variety to the latter species must also include the former

species as a variety under the same name. If at the other end of the series we should be permitted to add *Ammonites Turneri*, which we think will perhaps prove to be merely a local variety of *A. obtusum*, the evidence becomes additionally strong. This variety, or species, has only the faintest marks of channel grooves, even upon the first quarter of the sixth volution, both upon the shell and upon the cast, and in the typical *Turneri* the pilæ at this age run nearly to the base of the keel. The septal proportions and outlines of the lobes and cells are the same as in the typical *Asteroceras obtusum*, and in all respects it is similar to that species, differing only in the later or slower production of the channels and keel and in its somewhat smaller size.

A third opinion that all of these were distinct species, may be answered first, by reference to the accelerations in the development of the pilæ occurring between the different individuals of the first variety, which in that case become types of varieties, and, also, by citing other species. Thus one species of a lower genus *Arnioceras incipiens*, all the specimens of which are from one locality, fades by regular and inseparable gradations from specimens whose whorls possess no channels in the adult to those which have these parts better defined even at an early age than in the adult of the third variety described above. This position might also farther be strengthened by showing that this presence or absence of channels becomes in the Middle Lias of such importance that it constitutes a generic distinction in the family group (*Hildoceratidæ*) which is nearest allied to that which includes the species referred to above, the family of *Discoceratidæ* (*Arietes*). Thus *Hildoceras* (*Ammonites bifrons* and *Walcottii*) differs from *Grammoceras* (*Amm. striatulus, Amm. Aalense*, etc.) principally in these characteristics.*

The presence or absence of channels, therefore, or any change of form to which the abdomen may be subjected, cannot, to use the terms of the modern systematist, be considered as of slight importance even though we find them, when first introduced, subject to simple varietal changes in some species.

The limits of a review do not permit us to continue this part of the subject. Leaving many similar instances, therefore, to appear in due course of publication, we will pass on to the consideration of the application of the theory to another series of facts. We refer to the changes which take place during the old age of the individual and also of the group. They bear directly upon that portion of Professor Dawson's remarks which refer to the possibility of determining beforehand the future course of the changes of a group, but have been accidentally passed over in silence by him. He has also given Professor Cope the undivided credit of discovering the law of acceleration, whereas the memoir we have referred to above, which has escaped Professor Dawson's notice, will remove all doubt that the aim of a large part of the investigations there

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* Bulletin of the Museum of Comparative Zoology, No. 5, p. 99.

recorded is identical with those of Professor Cope's more elaborate essay. We have no desire for controversy and regard scientific claims as generally speaking not worth contending for, but feel that silence, in the present instance, would place in a false light the object of these investigations, and vitiate the original value of the results of much labor not yet published. The quotation below will serve to justify these remarks, and at the same time bring us back to the more agreeable and legitimate subject of this review.

"This law" (of acceleration) " applied to such groups as have been mentioned, produces a steady upward advance of the complication. The adult differences of the *individuals* or species being absorbed into the young of succeeding species; these last must necessarily add to them by growth, greater differences which in turn become embryonic, and so on; but when the same law acts upon some series whose individuals alter the shell in old age, precisely the reverse occurs, and a general decline takes place. The old age characteristics in due course of time or structure, become embryonic and finally affect the entire aspect of the higher members of the series."* In other words there are certain degradational characteristics first found in the old age of the shell, which are inherited at earlier periods by species standing higher in the series, just as the adult characteristics are inherited by them in the young. Thus the degradation and ultimate extinction of groups of animals may be accounted for by the law of acceleration quite as accurately as their rise and progress in organization.

These degradational tendencies bring about in the old age of the individual quite a close resemblance to its own young,† and in the group their inherited influence may be traced to its ultimate results in the peculiar unrolled shells of the Cretaceous Ammonites, which are, form for form, the same as those of the earlier Nautiloids in the older formations. In other respects also the aberrant Ammonoids of the Cretaceous may be shown to be degraded species; in their simpler septa when compared with the normal formed ammonites, having in the adult only the six lobes of the young, and in their ornamentation, and simple, rounded, keeless and channelless whorls.

Thus the retardation of development which is invoked to account for the tendency of species to return to forms analogous with those with which they began; or, in other words, to complete cycles either as a series or in geological time, becomes only another phase of the law of acceleration. The very complete analogy, to say the least, which exists between the life of a group and that of an individual member points very decidedly to some law that governs alike the growth and decline of the individual and the group to which it may belong. The struggle for existence may, and probably does as well as physical circumstances strongly influence the action of this law, but that it has no controlling influence is

* "On the Paralellism," etc., p. 232.

† First noticed by D'Orbigny. Pal. Francaise. Terr. Cretaces p. 381.

proved, we think, by the fact that degradational or senile tendencies are inherited.

In this connection I would suggest that the Turrillites and other allied spiral shells, will ultimately be found to be the legitimate descendants of the deformed Turrillites described by D'Orbigny from the Lower Lias beds. It is now generally acknowledged by European writers that these forms are discoidal ammonites that have departed from the usual mode of growth common to their species, and instead of revolving always in the same plane the whorl has become slightly assymetrical, and thus begun to form the assymmetrical spiral of the genus Turrillites. This tendency is quite common with the septa of *Psiloceras psilonotus* and other species, and in the shell, also, but is so faintly expressed that it is difficult to distinguish from the effects of compression. If this and other instances of a similar kind be finally substantiated we have here still another application of the law of acceleration to characteristics, which naturalists have been hitherto accustomed to call deformities.

According to the theory of natural selection only favored races can prolong their existence by perpetually inheriting the advantages of their ancestors, and certainly the degradational characteristics as displayed in all the terminal species of the ammonoids cannot be explained in this way. Here also we have the limitation of the cycle of changes or variations, of which a species or form may be supposed to be capable, at least partially accounted for; and as Professor Dawson and others have pointed out, the theory of natural selection makes no provision for such restrictions. Reversion cannot be called upon to explain the return of the Nautiloid forms in the Ammonoids of the Cretaceous, because they show the effect of traceable inherited characteristics continually augmenting in force, and because these are senile to the group, and are no more reversionary than the old age of the individual is a reversion to its own younger state. They are accomplished by methods opposed to the metamorphoses occasioned by the progress of the group in structure and by growth in the individual. They take place by a gradual suppression or atrophy of the adult characteristics in the individual, and in the group, by an unrolling of the closely coiled and deeply involute whorl of the Jurassic Ammonites, and they occupy the polar extreme of structure and life in both cases.

We would remark, in conclusion, that Professor Dawson does not wholly commit himself to the new theory, but regards it as "holding forth the most promising line of investigation" as yet advanced. Though the author of the theory in common with Professor Cope, we cannot refuse to endorse Professor Dawson's judgment as regards this decision also. The law certainly explains much which has been hitherto inexplicable, but until the extent to which it may be modified by physical causes, and perhaps natural selection, be fully understood, an unprejudiced mind cannot consider it as capable of clearing away all our present difficulties. It gives us, perhaps the means of asserting that the plasticity of organs

have certain limits; that variations can arise from natural selection, or physical changes, only when these act in given directions and for a given time, after the expiration of which, whether in the individual or the group, if sudden death do not intervene, all changes must be degradational in character. Physical causes, and the struggle for existence can no longer improve the vitiated organization when it has passed this period. Its death is decreed as certainly as its line of developmental changes must have been before it was born, and whatever agency other laws may have, they can only act with more or less force and velocity in these predetermined paths of progress and decline, or cut them short by the destruction of the organization. — A. Hyatt.

The Torrey Botanical Club, which, under the auspices of its President and Nestor, meets at the Herbarium in Columbia College, began with the year to issue its "Bulletin," in monthly numbers of four pages each. The notices and memoranda thus issued relate chiefly to the local flora of New York, which is the special charge of the Club; but matters of more than local interest are touched upon, making it well worth the attention of our botanists throughout the country. For example, in the February number, Mr. Leggett, the editor, explains the anomaly of *Lepidium Virginicum* having accumbent cotyledons, contrary to all the rest of the species, showing that what may be termed the petioles of the flat cotyledons, in line with the radicle, and in which the bend is made, are in the position answering to incumbent, and so the cotyledons take the accumbent position by a twist of ninety degrees. The "Bulletin" is furnished, upon application to the editor, 224 East Tenth street, New York, for a dollar a year, or seven copies for five dollars.

Fossil Plants from the West.* — This report closes Dr. Hayden's report reviewed by us in March, 1870. By some oversight we confused it with a former paper of Professor Newberry, and thus passed by some of the most important results of the explorations. The first portion is a general review of the geology of North America, and as these government reports, notwithstanding their wide distribution, generally have but few non-scientific readers, we shall republish this for the benefit of our subscribers in some succeeding number.

The chapter on the "Cretaceous Flora" gives a concise summary of the various government expeditions which have made collections of the plants of this period. The conclusions reached are identical with those which we have already quoted in the review referred to above in March, 1869, page 41.

Among the Miocene plants Dr. Newberry finds *Onoclea sensibilis*, a species undistinguishable either from the living forms of this species or those found in Europe, only on the island of Mull, off the west coast of Scotland. This and the large number of other identical miocene species, lead to the inference that North America and Europe were connected by

* Report on the Cretaceous and Tertiary Plants. By Professor J. S. Newberry.

an intermediate continent. "If this inference should be confirmed by future observations, we should then see how the eocene tropical or sub-tropical flora of Europe was crowded off the stage by the tropical flora of the miocene, which latter accompanying a depression of temperature, had migrated from America, while the eocene flora had retreated south and east, and is now represented by the living Indo-Australian flora, characterized by its *Hakeæ*, *Dryandreæ*, *Eucalypti*, etc., etc., which form so conspicuous an element in the eocene flora of Europe." Instances in which the miocene flora occurs on the McKenzie River, Disco Island, Iceland, and the Island of Mull are then brought forward to show that this land connection must have occurred to the northward, and that the country was then in possession of a milder climate than now reigns in the same latitude.

In discussing the causes which produced this difference of climate Professor Newberry gives his adherence to none in particular, but thinks that the deflection of the Gulf Stream would be the most natural method and at the same time places an objection in the path of the astronomical theorists, which they will find it difficult to combat. It will be remembered by our readers that many of the geologists of the day account for the former presence of a warm climate in the Arctic region, by supposing that the earth has, in former times, passed through a warmer region in space. This cannot be assumed to be the cause in the present instance; for any "cosmical cause, producing a general elevation of temperature on the earth's surface, would have given us a tropical flora on the Upper Missouri, whereas we find in the miocene flora there, as yet no tropical plants."

Relations of the Rocks in the Vicinity of Boston.* — Professor Shaler regards all the syenites of this vicinity as of sedimentary origin, and rejects the old theory of their Plutonic origin. In this he is supported by the late discoveries of the Eozöon in this vicinity, and by the researches of Professor T. Sterry Hunt, published in the last number of the "American Journal of Arts and Sciences." The section of the rocks in the neighborhood of Quincy is described as consisting of a layer of quartzites "to the north of the Quincy Syenite Hills, a hidden section of about three hundred feet thickness, and the Braintree series of two hundred feet. Another section of the Chesnut Hill Reservoir is also described, composed of Cambridge slates for seven hundred feet, Roxbury conglomerate for ten feet, thirty feet more of slate and conglomerate again extending to the edge of the Charles River flats in Brighton, where they give place to a sandstone.

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* Abstract of Some Remarks on the Relations of the Rocks in the Vicinity of Boston. By N. S. Shaler. Proc. Boston Soc. Nat. Hist., vol. xiii. Dec. 3, 1869. Pamph., pp. 7.

NATURAL HISTORY MISCELLANY.

BOTANY.

On the Fertilization of Grasses. — In gently flowing rivers of tropical America grow many fine aquatic grasses, species of Luziola, Oryza, Leersia, etc. The following note is from my journal under date of December, 1849, when threading in my canoe among the islands of the Trombetas: — "This channel was lined on both sides by a beautiful grass — a species of Luziola — growing in deep water, and standing out of it two or three feet. The large male flowers, of the most delicate pink, streaked with deep purple, and with six long yellow stamens hanging out of them, were disposed in a lax terminal panicle; while the slender green female flowers grew on the bristle-like branches of much smaller panicles springing from the inflated sheaths of the leaves that clothed the stem. As the Indians disturbed the grassy fringe with the movement of their paddles, the pollen fell from the antlers in showers," and would, doubtless, some of it, attain the female flowers disposed for its reception.

A parallel case to the above is that of the common Maize (*Zea Mays* L.), where the male flowers are borne in a long terminal raceme or panicle, and the female flowers are densely packed on spikes springing from the leaf-axils. Here the male flowers must plainly expand before the pollen contained in their anthers can be shed on the female organs below, whether of the same or of a different plant. That there are frequent cross-marriages in Maize is evidenced by the numerous varieties in cultivation in countries where it is a staple article of food, as in the Andes of Ecuador, where nine kinds, varying in the color of the grain (through white, yellow, and brown, to black), in its size, consistence, and flavor, are commonly cultivated; besides many others less generally known.

In *Pharus scaber* (H. B. K.) another tall broad-leaved grass, the spikelets stand by twos on the spike — a sessile female spikelet, and a stalked male spikelet.

In the fine forest grasses of the genus Olyra, whereof some species, such as *O. micrantha* (H. B. K.). rise to ten feet in height, and have lanceolate leaves above three inches broad, and a large terminal panicle, with capillary branches, like those of our *Aira cæspitosa*, it is the lower flowers that are male, with large innate (not versatile) anthers, and the upper that are female, with two large stigmas, that are either dichotomously divided, or clad with branched hairs, thus exposing a wider surface to the access of the pollen. And as the panicle is often pendulous, many of the male flowers, although placed lower down the axis, are actually suspended over the terminal female flowers.

It is generally to be remarked of declinous grasses, that either the male

flowers are very numerous, as in *Zea Mays*, or the stamens are multiplied in each male flower, as in Pariana, Leersia, Guadua, etc.; or the stigmatic apparatus of the female flowers is enlarged, so as almost to insure impregnation, as in Olyra and Tripsacum.

In the Bambuseæ I have gathered, belonging to the genera Guadua, Merostachys, and Chusquea, the flowers are more or less polygamous, and the stamens of the male flowers often doubled. But there is scarcely a genus in the whole order which is not described as having some flowers by abortion, neuter or male, and especially those that have biflorous spikelets, such as the Paniceæ. Some grasses, of normally hermaphrodite genera, are not unfrequently truly unisexual, such as certain species of Andropogon. I have occasionally seen panicles of *Orthocladus rariflorus* (Nees), a grass peculiar to the Amazon, quite destitute of stamens, and therefore purely female.

To come home to our own country: Is all the pollen wasted that a touch or a breath sets free from the flowers of grasses in such abundance? Watch a field of wheat in bloom, the heads swayed by the wind, lovingly kissing each other, and doubtless stealing and giving pollen. Consider, too, that throughout Nature, heat or moisture, or both, are essential to the emanation of the impregnating influence. In all our Festuceæ, as well as in Cynodon, Leersia, and some other genera, the stigmas are protruded from the side or from the base of the flower at an early stage, often before the stamens of the same flower are mature — thus as it were inviting cross fertilization from the more precocious stamens of other plants which are already shedding their pollen.

All who have gathered grasses will have remarked that some have yellow anthers, others pink or violet anthers; and that anthers of both types of color may co-exist on distinct individuals of the same species. The same peculiarity is just as noticeable in tropical grasses, and (without professing to give a complete physiological explanation of it) this is what I have observed respecting it. The walls of the anther-cells are usually of some shade of purple, but are so very thin and pellucid, that when distended with mature pollen the yellow color of the latter is alone visible. When the pollen is discharged, the anthers resume their original purple color, shortly, however, to take on the pallor or dinginess of decay. Where the anthers emerge of a purple hue, and change from that to brown, it will probably be found that they have discharged their pollen while still included in the flower. These observations, made without any reference to the question now in hand, require to be renewed and tested: and in them, as in all that precedes, I am open to correction.

Of grasses with bisexual flowers, there are two ways in which the ovary may be fertilized, namely, either by the pollen of its own flower (closed or open), or by that of other flowers, after the manner of the declinous species. In the latter case, the pollen may be transported by the wind, or in the fur of animals (as I have observed the seeds of Selagin-

ellas in South America), or in the plumage of birds. The agency of insects has not been traced in the fertilization of grasses, but may exist. The little flies I have seen on the flowers of grasses seemed bent on depositing their eggs in the nascent ovaries, but may also have aided in cross-fertilization. In the Amazon Valley grasses are often invested by ants, who, indeed, leave nothing organic unvisited throughout that vast region; and they also, I think, cannot help occasionally transferring grains of pollen from one flower to another.

The flowers of Palms and Grasses agree in being usually small and obscurely colored, but contrast greatly in the former being in many cases exquisitely and strongly scented, whereas in the latter they are usually quite scentless. The odor of Palm-flowers often resembles that of Mignonette; but I think a whole acre of that "darling" weed would not emit more perfume than a single plant of the Fan Palm of the Rio Negro (*Mauritia Carará* Wallace). In approaching one of these plants through the thick forest, the sense of hearing would perhaps give the first notice of its proximity, from the merry hum of winged insects which its scented flowers had drawn together, to feast on the honey, and to transport the pollen of the male to the female plants; for it is chiefly diœcious species of Palms that have such sweet flowers. The absence of odoriferous flowers from the grasses seems to show that insect-aid is not needed for effecting their fecundation, but does not render its accidental concurrence a whit less unlikely.

That grasses, notwithstanding their almost mathematical characters, vary much as other plants do, is plain from the multitude of osculating forms (in such genera as Eragrostis, Panicum, and Paspalum), which puzzle the botanist to decide when to combine and when to separate, in order to obtain what are called "good species." Hence the conclusion is unavoidable that in grasses, as in other plants, variations of surrounding conditions induce corresponding modifications of structure, and that amongst the former must be enumerated cross marriages, however brought about. If the flowers of grasses be sometimes fertilized in the bud, it is probably exceptional, like the similar cases recorded of Orchids and many other families.

To conclude: the more I ponder over existing evidence, the more I feel convinced that in its perfect state every being has the sexes practically separated, and that natural selection is ever tending to make this separation more complete and permanent; so that the hypothesis of Plato, that the prototype even of man was hermaphrodite, may one day be proved to be a fact! — Dr. R. Spruce, *Scientific Opinion*. [See his paper in Journ. Linn. Society.]

Fungi on Insects. — Dr. Bail of Danzig, in a recent pamphlet, calls attention to the various kinds of fungus that are parasitic upon the larvæ of different insects, and his investigations are of some practical importance in relation to a possible check to the destruction of forest-trees, which goes on to an enormous extent in North Germany, through the

ravages of caterpillars. In certain seasons these caterpillars appeared to be attacked by an epidemic, their bodies being swollen to bursting, and white threads being visible between the rings of the body, which seemed to issue from the body itself. In this condition great numbers were found still clinging to the leaves. The destroying agent had been identified by Dr. Reichhardt of Vienna as the mycelium of a fungus which he named *Empusa aulicæ*. The distribution of the *Empusa* is very considerable; the only order of insects which is not at present known to be subject to their attacks being the *Neuroptera* (dragon flies, etc.); they are known to be parasitic upon *Coleoptera* (beetles), *Hymenoptera* (bees, ants, etc.), *Lepidoptera* (butterflies and moths), *Diptera* (flies and gnats), *Orthoptera* (crickets, etc.), and aphides, either in the larva or perfect condition, on water-insects, and even the same species on amphibia and fishes. Not only is their distribution over so many different animals remarkable, but also the prodigious rapidity of their development in the individual. The common house-fly is, in some years, destroyed by this parasite in vast numbers, and the dung-fly has been in certain districts almost annihilated. In the forests of Pomerania and Posen the caterpillars have been killed by it in such quantities that it may be considered to have saved the trees from total destruction. The fungi which Dr. Bail found to be the most destructive to insect life were those described by authors as *Cordyceps militaris*, *Isaria farinosa*, and *Penicillium glaucum;* the two latter forms he inclines to unite as different stages of growth of the same plant. — *The Academy.*

Insect-fertilization of Flowers. — In an article contributed to "Scientific Opinion" by Professor Delpino, he passes from orchids, which since Darwin's work upon them have attracted much attention in this respect, to the related families, one of which is familiarly represented in our gardens by the *Canna*, or Indian Shot. Here the arrangements depends upon the viscidity of the pollen, and the bursting loose of the style; the pollen is first deposited on an expansion of the style, whence it is taken away by the insect, to be deposited upon the stigma of the flower next visited.

Collected Notes on American Oaks. — *Concluded.* A. De Candolle, in "Prodromus" XVI, 2, 1864, describes two hundred and eighty-one species. Of these one hundred and twenty-two are American; of which twenty-nine are doubtful. He admits *Q. olivæformis* Michx., *bicolor* Willd., *grisea* Lbm., *pungens* Lbm., *hastata* Lbm., *Leana* Nutt., as species. Thirteen species from Endlicher's list are made varieties of others; sixteen are synonyms of others. De Candolle proposes three new species: *Q. Lindeni* (collected in New Grenada in 1842, by Linden), *Wislizeni* (1846, in New Mexico by Wislizenus), and *omissa* (from Seemann's collection, but omitted in "Plantæ Hartwegianæ"). *Q. dumosa* Nutt., and *acutidens* Torr., are not mentioned. Counting these omitted species, and dropping *olivæformis* and *Leana* as such; then uniting *grisea* with *oblongifolia*

and *pungens*, and placing *hastata* in *Emoryi*, we have ninety American species. But even this number may be in the future greatly reduced, particularly in the Mexican species, which are founded on a limited number of specimens, and with the habitat for the most part not stated.

Michaux attempted the first methodical disposition of the genus, as above mentioned, which was after him maintained by Pursh, Nuttall and Elliott. In Europe the important character taken from the ripening of the fruit was entirely neglected. Only Koch, in "Flora Germanica," 1837, gives notice that *Q. Cerris* ripened its fruit in the second year.

Then Spach, in Vol. XI. of his "Histoire Naturelle des Veg. Phanerog." 1842, applied this character to his natural arrangement of the oaks, which is founded on the form and duration of the leaves, the cup and the ripening. His disposition is this:

I. Deciduous leaves: Esculus.
   1. Robur: Leaves sinuose, pinnatifid; lobes not bristle-pointed. Maturation annual; scales of the cup small, oval, appressed.
   2. Cerroides: Leaves pinnatifid, lobes not bristle-pointed. Maturation annual. Scales of the cup, the lower imbricated and appressed; the upper ones subulate, loose and much longer.
   3. Erythrobalanus: Leaves entire, mucronate or trilobed, or pinnate-lobed, bristle-pointed. Maturation biennial. Scales of the cup small, appressed, imbricated, not subulate.
   4. Cerris: Leaves late deciduous or subpersistent, coriaceous; lobes or teeth bristle-pointed. Female flowers often from buds without leaves, and so the fruit lateral on the year's shoot. Maturation annual. Scales of the cup echinate.
   5. Gallifera: Leaves late deciduous, becoming yellowish and brownish; lobes or teeth bristle-pointed. Maturation biennial. Scales of the cup short, appressed.

II. Leaves persistent: Ilex.
   6. Suber: Maturation annual.
   7. Coccifera: Maturation biennial.

Endlicher maintained the same disposition and characters, only changing *Cerroides* into Elæobalanus, and while Spach considers only the European, Western-Asiatic, and American species, he introduces the Eastern Asiatic, which he puts into the subgenus Cyclobalanus except one, *Quercus cuspidata*, which forms his subgenus Chlamydobalanus; the former are all in his subgenus Lepidobalanus.

Gay, in "Ann. des Sc. Nat., IV, 6," pointed out the errors in the above disposition. The character of maturation is mistaken in three groups: *Cerris, Gallifera* and *Suber*. *Q. Cerris* ripens its fruit the second year; so also *Q. ægilops* L., *castaneæfolia* C. A. Mey, and *persica* Jaub, & Spach. So the whole group Cerris has the maturation biennial. *Pseudosuber* Desf., and *hispanica* Lam., which Endlicher put as one species under Gal-

lifera, belong to Cerris. Spach forms, for the single species, *Q. infectoria* Oliv. To the group *gallifera*, with biennial maturation, Endlicher added *Q. humilis* Lam., *alpestris* Bois., and *hispanica* Lam., but the two former, as well as *infectoria*, ripen the fruit the first year. These groups contain only European species; the American botanist is more interested in Spach's group, *Suber*, with the species *Q. virens* Ait. This species was taken by all the authors from Michaux, the elder, to A. Gray, as maturing the fruit in the second year. Spach puts it with Suber, with annual maturation. In the "Prodromus," and in the latest edition of "Gray's Manual," it is annual. Gay agrees with, but does injustice to, Endlicher, when he says that Endlicher's seventy-seven American and thirty-five east Asiatic species, which never have been examined upon their maturation, had been joined with Suber. Endlicher ranges neither *virens* nor the rest in the group Suber, but into no group at all. His arrangement is thus: Ilex — 1. Mediterraneæ et orientales; VI. Suber. VII. Coccifera. 2. Americanæ. 3. Japonicæ, etc.

The disagreement of view in respect to maturation is explained by the fact that until now two different species, with different maturation, have been taken for one. Gay describes a species which grows in France and Spain along the Atlantic, and furnishes all the cork used in these countries. It is *Quercus occidentalis* Gay, with biennial maturation, and was kept before the discovery of Gay for Suber. It is remarkable that often quite similar species differ only in maturation, and it is not impossible that the mistake concerning *Q. virens* grounds on an interchange of *Q. cinerea* and the former. In regard to the first groups Gay follows Endlicher and Spach; but I think there is an objection to the second group Elæobalanus. The subulate prolongation of the upper scales of the cup is so variable that this character is not profitable to be used in a natural arrangement. I have seen fruits of *Q. macrocarpa*, in which the prolongation of the scales was scarcely perceptible; on the other hand I have seen fruits of *Q. bicolor* or *Prinus discolor*, with very much prolonged scales. It is my opinion that *Q. macrocarpa* falls under the group Robur, and that the group Elæobalanus should be dropped.

There are two essays of A. De Candolle in "Ann. des Sc. Nat. ser., IV, Vol. XVIII." (1862): *Sur le fruit du chêne* and *Etude sur l'éspèce.* De Candolle considers the proposed characters as incompetent to form natural groups in the section Lepidobalanus; for species closely related by one character are often disjoined by the other, but they are good enough to form artificial subdivisions, which are necessary from the great number of species. A new diagnostic character, discovered by De Candolle, is for the same reason unfit to form natural groups. This is the position of the abortive ovules at the base, or at the apex, of the ripe seed. Working out the genus *Quercus* for the "Prodromus" De Candolle mustered the different characters, to find out the best for determining the species. He considers as good ones, the size, form and pubescence of the stipules; the nervation of the leaf, respecting the direction and relative size of the

nerves of different degrees; their number to a certain point (?), the pubescence of the leaves and twigs (isolate or aggregate, on nerves or parenchyma); its length in younger parts; the duration of the leaves; the anthers (smooth or pubescent); the form of the cups in the upper part in the ripe fruit; the size of the cups, the general form and size of their scales; the maturation and the position of the abortive ovules.

Such characters as the following which, comprising many specimens, more or less differ on the same twig, are only good to determine varieties, viz.: the length of the petioles, the form of the leaf in regard to its diameter, to the base (acute, obtuse, or cordate); the depth of the incisures; the pointed or obtuse termination of the leaf; the presence and form of the bracts of the aments; the number of lobes of the perigone in the male flowers; the number of stamens; presence or absence of a mucro at the apex of the anthers; the length of the peduncle of the female flower; the swelling of the scales of the cup; the relative length of the acorn; the caducous or persistent pubescence of the underside of the leaves; the length and direction of bristles; the male flowers, whether pedicelled or sessile; the form of the cup at the base; the termination of the lower scales of the cup; the direction of the scales in the ripe fruit.

De Candolle adopts the three subgenera of Endlicher, adding two more from species which Endlicher puts under Lepidobalanus. The subgenus Androgyne, is formed by the single (Californian) species, *Quercus densiflora* Hook, which has the flowers of both sexes in an upright spike, male above, female below, the male flowers in bundles with three bracts, stamens double the number of the lobes of the perigone, the abortive ovules at the apex of the seed. The other new subgenus is Pasana, with South Asiatic species. All the other American species belong to the subgenus Lepidobalanus. The arrangement in the "Prodromus" is thus:

I. LEPIDOBALANUS.

§ 1. Abortive ovules below. Maturation annual.

* Leaves deciduous.

Q. LYRATA Walt., Q. MACROCARPA Michx. (with var. abbreviata and minor); Q. OLIVÆFORMIS Michx., *Q.* BICOLOR Willd. (*Q. Prinus tomentosa* Michx., *Prinus discolor* Michx. f., *Michauxii* Nutt.). There is a variety cultivated in France, *β. platanoides=Q. prinus platanoides* Lam.=*Q. velutina* herb l'Her.=*Q. pannosa* Bosc. (which is, perhaps, *Q. mollis* Nutt.=*Q. filiformis* Muhl.). Q. PRINUS L.=*Q. prinus palustris* Michx. (De Candolle refers to this the figure *Q. montana* in Emerson's Trees of Mass., Pl. 6, and the text to the next). *Q. Prinus β acuminata=Q. castanea* Muhl. (Emerson says the younger Michaux makes this a distinct species. This is not so as far as I know). *Q. Prinus γ monticola=Q. Prinus foliis obovatis* Wangenh.=*Q. montana* Willd., *Q. Prinus δ chincapin=Q. prinoides* Willd. =*Q. Prinus pumila* Mich.=*Q. chincapin* Ph.=*Q. Prinus chincapin* Michx. fil. *Q.* STELLATA Wg.=*Q. obtusiloba* Michx.=*Q. villosa* Walt.? There are three varieties *β Floridana=Q. Floridana* Shutlew, *γ depressa* (Nutt.) on

the upper Missouri, δ *Utahensis* the only oak between Salt Lake and Sierra Nevada, Q. ALBA L. with two varieties (?) β *repranda*, γ *microcarpa*.

Q. UNDULATA Torr.=*Fendleri* Lbm. Two varieties β *obtusifolia*, γ *pedunculata*. Q. DOUGLASII Hook, with three varieties, β *Gambellii*=*Q. Gambellii* Nutt., γ *novo-Mexicana*=*Q. Gambellii* Lbm. δ *Neaei*, *Q. Neaei* Lbm.=*Q. Douglasii* Bth. Q. LOBATA Née=*Q. Hindsii* Benth.=*Q. longiglanda* Torr. Q. GARRYANA Hook. Q. DRUMMONDII Lbm. These five species are very likely varieties of one species nearly related to the European Q. Robur.

The following are Mexican and Central American species, with dentate or entire leaves; the maturation of the fruit is not sufficiently known.

Q. CORRUGATA Hook, Q. INSIGNIS Mart. Gal., Q. STROMPOCARPA Lbm., Q. GALEOTTII Mart., Q. CIRCINATA Née, Q. MAGNOLIÆFOLIA Née, with two varieties, β *lutea*=*Q. flava* Née, γ *macrophylla*=*Q. macrophylla* Née=*Q. resinosa* Lbm., Q. OBTUSATA HB.=*Q. affinis* Mart. Gal.; the varieties β *pandurata*=*Q. pandurata* HB. γ *Hartwegii*=*Q. ambigua* HB.=*Q. Hartwegi* Benth.=*Q. nudinervis* Lbm., Q. POLYMORPHA Cham et Schl.=*Q. petiolaris* Benth.=*Q. varians* Mart. Gall.=*tuberculata* Lbm., Q. OMISSA A. DC., Q. LAXA Lbm.=*Q. callosa* Mart., Q. LAETA Lbm.=*Q. obtusata* var. Bth., Q. BENTHAMI A. DC.=*undulata* Bth., Q. TAPUXAHUENSIS A. DC.=*Q. salicifolia* Bth., Q. CORTESII Lbm., Q. SARTORII Lbm., Q. SALICIFOLIA Née, Q. SEEMANNI Lbm., Q. GHIESBREGHTI Mart. Gal., Q. BARBINERVIS Benth., Q. GLAUCOIDES Mart., Gal.=*Q. elliptica* Lbm.

* * Leaves persistent.

Q. HUMBOLDTII Bonpl., Q. CITRIFOLIA Lbm., Q. COSTARICENSIS Lbm., Q. LINDENI A. DC., Q. TOLIMENSIS HB., Q. TOMENTOSA Willd.=*Q. pedunculata* Née=*Q. callosa* Bth. There are four varieties:—α. *communis*=*Q. tomentosa* Bth., β *bullata*, γ *diversifolia*=*Q. diversifolia* Née, δ. *abbreviata*, Q. RETICULATA HB.=*Q. spicata* HB=*decipiens* Mart. Gal., the variety β *Greggii*, Q. PULCHELLA HB., Q. GLABRESCENS Bth. with the var. β. *integrifolia*, Q. GRISEA Lbm. (probably *Q. oblongifolia* Torr.) Q. REPANDA HB., Q. MICROPHYLLA Née=*Q. repanda* Bth. with the var. β *crispata*, Q. OBLONGIFOLIA Torr., Q. PUNGENS Lbm., and HASTATA Lbm. (both being *Q. Emoryi* Torr.) Q. BERBERIDIFOLIA Lbm., Q. AGRIFOLIA Née=*Q. oxyadenia* Torr. I examined a number of acorns of this species and found in all of them the abortive ovules at the apex of the seed!, Q. CHRYSOLEPIS Lbm.=*Q. crassipocula* Torr.=*Q. fulvescens* Kell., Q. VIRENS Ait.=*Q. sempervirens* Cat.=*Q. Phellos* β. L.=*Q. Virginiana* Mill.=*Q. oleoides* Cham. and Schl.=*Q. retusa* Lbm., Q. LUTESCENS Mart. Gal.

§ 2. Abortive ovules below. Maturation biennial.

Leaves persistent.

Q. CRASSIFOLIA HB.=*Q. rugosa* Née=*Q. spinulosa* Mart. Gal., Q. SPLENDENS Née, with the var. β. *pallidior*=*Q. crassifolia* Bth., Q. SCYTOPHYLLA Lbm., Q. SIDEROXYLA HB., Q. LAURINA HB.

§ 3. Abortive ovules above. Maturation biennial.

* Leaves deciduous.

Q. FALCATA Michx.=*Q. elongata* Willd.=*Q. discolor* Ait.; there are two varieties, β *Ludoviciana*, γ *triloba*=*Q. triloba* Michx.=*Q. cuneata* Wg., Q. ILICIFOLIA Wg.=*Q. Banisteri* Michx., Q. CATESBÆI Michx., *Q. rubra* L. with the var. β *runcinata*, Q. PALUSTRIS Du Roi=*Q. rubra ramosissima* Marsh.=*Q. rubra dissecta* Lam., Q. GEORGIANA A. Curt., Q. COCCINEA *Q. coccinea* Wg.=*Q. rubra* α L. There are four varieties: α *coccinea*=*Q. coccinea* Michx.=*Q. ambigua* and *borealis* Michx. fils.; β *nigrescens*=*Q. tinctoria sinuosa* Michx.=*Q. discolor* Willd.=*Q. tinctoria* Michx. fils.; γ *tinctoria*=*Q. tinctoria* Batr.=*Q. tinctoria angulosa* Michx.=*Q. velutina* Lam., δ *Rugelli*, Q. SONOMENSIS Bth.=*Q. rubra* Bth. in Pl. Hartw., Q. LEANA Nutt. De Candolle considers the hybridity of this as not certain. It is perhaps not so scarce as supposed; there is besides the known individuals one in Fulton County, Illinois, and one near Peoria, the latter in the immediate neighborhood of *Q. coccinea* and *imbricaria*. Q. TOTUTLENSIS A. DC., Q. PHELLOS L. with the var. β *subimbricaria* (hybrid?), Q. IMBRICARIA Michx. with a var. β *spinulosa*, Q. NIGRA L.=*ferruginea* Michx. fils.=*Q. Marilandica* Cat.; there are two varieties, β *quinqueloba*, γ *tridentata*, Q. SKINNERI Bth., Q. XALAPENSIS HB., Q. WARSCEWICZII Lbm.=*Q. glabrescens* Seem.=*Q. oöcarpa* Lbm., Q. CALOPHYLLA Cham. and Schl.=*C. Alamo* Bth.=*Q. intermedia* Mart. Gal.=*Q. acuminata* Mart. Gal.

* * Leaves persistent

Q. GRANDIS Lbm., Q. ACUTIFOLIA, Née=*Q. furfuracea*, there are five vars.: β Bonplandi, γ *angustifolia*=*Q. acutifolia* Thib., δ *conspersa* Bth.=*nitida* Mart. Gal. ε. *longifolia*=*longifolia* Lbm. ζ *microcarpa*, Q. WISLIZENI A. DC., Q. AQUATICA Walt., Willd.=*Q. nigra* L. α=*Q. uliginosa* Wg.=*Q. Phellos maritima* Michx.=*Q. maritima* Willd., of this five varieties are enumerated; β *laurifolia*=*Q. laurifolia* Mich.=*Q. hemisphærica* Bartr. γ *heterophylla*=*Q. heterophylla* Michx. fils. (hybrid?), δ *stipitata*, ε. *dentata*=*Q. dentata* Bartr.=*Q. nana* Willd? ζ *myrtifolia*=*Q. myrtifolia* Willd. Q. NITENS Mart. Gal.=*Q. commutata* Lbm., four vars.; β *podocarpa* γ *ocoteæfolia*=*Q. ocoteæfolia* Lbm., δ *major*, ε *subintegra*=*Q. laurifolia* Bth., Q. LANCEOLATA HB. with the var. β *undulato-dentata*=*Q. laurina* Lbm., Q. DEPRESSA HB., Q. GRANULATA Lbm., Q. LINGUÆFOLIA Lbm., Q. ELLIPTICA Née with var. β *microcarpa*=*Q. perseæfolia* Lbm.=*Q. microcarpa* Lbm., Q. NECTANDRÆFOLIA Lbm., Q. LEIOPHYLLA A. DC.=*Q. lancifolia* Lbm., Q. CASTANEA Née=*Q. mucronata* Willd.=*Q. tristis* Lbm. the four vars.: β *sublobata*, γ *tridens*=*Q tridens* HB., δ *glabrata*=*Q. Mexicana* var *glabrata* Seem., ε *Mexicana*=*Mexicana* HB., Q. LANIGERA Mart. Gal., Q. CRASSIPES HB.=*Q. Mexicana* Bth., Q. CINEREA Michx.=*Q. Prinus* β L=*Q. Phellos cinerea* Spach, with four vars.: β *dentato-lobata*, γ *humilis*=*Q. humilis* Walt., δ *pumila*=*Q. pumila* Walt.=*Q. sericea* Willd.=*Q. Phellos pumila* Michx., ε *nana*, Q. RUGULOSA Mart. Gal., *Q.* CONFERTIFOLIA HB.

Then follow twenty-nine doubtful species.

II. ANDROGYNE.

Q. DENSIFLORA Hook. and Arn.=Q. *echinacea* Torr., the var. β *Hartwegi* is *Q. densiflora* Bth. in Pl. Hartw.

De Candolle supposes that of the species now known and described about two-thirds are provisional, and that when all the species of America and Asia now adopted are as well studied as the European, the "good species" will be reduced to about one hundred; then the American species would scarcely be more than fifty. This is credible when we perceive that the single species *Q. Robur* as proposed by De Candolle includes thirty-two varieties, and nearly a hundred synonyms. He went to work without prejudice or prepossession; he examined specimens by hundreds from different localities; and the result was that he had to drop many supposed "good species." What will become of our American, particularly the Mexican species, when once worked out in that way?

I thought I had a very good character, neglected by all authors, in the bud. The *Quercus coccinea*, wherever I found it here (Peoria) had a conical pointed tomentose five-ridged bud, with five rows of scales, and I was sure I should never see it otherwise. Now I get from northern Illinois a number of specimens with the acorns and all the other characters decidedly those of *Q. coccinea*, but some of them with smooth round buds, just as in *Quercus rubra*. We have now about half a dozen species united in *Q. coccinea;* the difference between *Q. rubra* and *Q. palustris* is so insignificant that the latter could be taken as a variety of the former, and perhaps, when we compare all the black and red oaks by many hundreds of specimens from all the different sections of the country, the limits between the species as now accepted would be very uncertain. Even *Quercus bicolor* seems to me to be a transitional form between *Q. macrocarpa* and *Q. Prinus;* to the former it is approximate by the often subulate scales, the pubescence of the lower side of the leaves, the buds, and the scaly bark of the twigs, which are often corky in *Q. macrocarpa*. An exact definition of the term "species" has never been proposed. Since Darwin's theory has made the stability of species questionable, it has lost much of its importance; but we want a certain term, be it species, or form, or race, or whatever it be: we want a name for an object, that it may be understood. That is the task of species. I cannot see more in it. — FRED. BRENDEL, *Peoria, Ill.*

DOES AIR DUST CONTAIN THE GERMS OF DISEASE? — Dr. Tyndall, in a recent lecture, asserted: (1), that the dust in the air we breathe is largely composed of organic particles; (2), that they are the germs of plants like the yeast and such-like fungi; and (3), that they are the means by which epidemic diseases are propagated.

The editor of "Scientific Opinion," claims that "each and all of these propositions appear to us incapable of being proved." He claims that a temperature of 212° or higher, such as Tyndall says will in a moment of time destroy them, will have no effect on them; secondly that "observations such as those of Pouchet, Joly, Musset, Mantegazza and others, all go to show that the germs of many of the lower vegetable organisms which are familiar to botanists, are not present in the air generally. Thirdly, the hypothesis that the contagious substance of small pox, scarlet

fever, cholera, and the like diseases" is a vegetable organism, rather than a minute particle of disorganized organic matter, is but an hypothesis and nothing more. So far as it has been attempted to be demonstrated by the experiments of Hallier and others, it has utterly broken down, and the ablest fungologists in the kingdom — Berkley and others — are distinctly opposed to it, as are, we believe, the more scientific of our modern physicians.

ZOOLOGY.

Habits of the Striped Squirrel. — I lately noticed in my garden a bright-eyed chipmunk, *Sciurus striatus*, advancing along a line directly towards me. He came briskly forward, without deviating a hair's breadth to the right or the left, till within two feet of me; then turned square towards my left — his right — and went about three feet or less. Here he paused a moment and gave a sharp look all around him, as if to detect any lurking spy on his movements. (His distended cheeks revealed his business: he had been out foraging.) He now put his nose to the ground, and, aiding this member with both forepaws, thrust his head and shoulders down through the dry leaves and soft muck, half burying himself in an instant.

At first, I thought him after the bulb of an *erythronium*, that grew directly in front of his face and about three inches from it. I was the more confirmed in this supposition, by the shaking of the plant.

Presently, however, he became comparatively quiet. In this state he remained, possibly, half a minute. He then commenced a vigorous action, as if digging deeper; but I noticed that he did not get deeper; on the contrary, he was gradually backing out. I was surprised that, in all his apparent hard work (he worked like a man on a wager) he threw back no dirt. But this vigorous labor could not last long. He was very soon completely above ground; and then became manifest the object of his earnest work: he was refilling the hole he had made, and repacking the dirt and leaves he had disturbed. Nor was he content with simply refilling and repacking the hole. With his two little hand-like feet he patted the surface, and so exactly *replaced the leaves* that, when he had completed his task, my eye could detect not the slightest difference between the surface he had so cunningly manipulated, and that surrounding it. Having completed his task, he raised himself into a sitting posture, looked with a very satisfied air, and then silently dodged off into a bush-heap, some ten feet distant. Here, he ventured to stop, and set up a triumphant "chip! chip! chip!"

It was now my turn to dig, in order to discover the little miser's treasures. I gently removed enough of the leaves and fine muck to expose his hoard — half a pint of buttercup seeds, *Ranunculus acris*. I took out a dozen seeds or so, re-covered the treasure as well as my bungling hands could, and withdrew filled with astonishment at the exhibi-

tion of cunning, skill and instinct of this little abused denizen of our field-borders.

In my boyhood days I had killed many of the little fellows; had unearthed the treasures in their burrows many times; had seen them, as I supposed, under every variety of aspect; in short, I thought I knew the chipmunk, every inch; but here was a new revelation of chipmunk character, for which I was totally unprepared.

It grieves me that I find it utterly impossible with words to convey adequately to you and your readers anything like a complete picture of the motions, the skill, the carefulness, the completeness of effect, and the consequent satisfaction exhibited by this little harvester. I have never read nor heard of any other man's having witnessed a similar scene, nor do I expect myself ever again to witness one. My opportunity for observation was perfect as it could possibly be; for he was so near me that I could almost stoop over and lay my hand on him, while he was half buried under the leaves.

The lesson is perfect; for what our chipmunk does, all chipmunks do, under the same circumstances. Where does instinct stop, and reason begin? Wherein does instinctive, *irrational* skill differ from rational skill? — IRA SAYLES, *Rushford, Alleghany Co., N. Y.*

CONCHOLOGICAL NOTES. — Mr. C. B. Fuller, of Portland, has recently discovered *Littorina litorea* Linn., at Kennebunkport, Maine. Willis records it as being found at Halifax, N. S., and we have always understood it to be common in the Bay of Chaleur. This is the first time it has been found so far south. This species is identical with the common Periwinkle of the English coast, and its increase may be hoped for, as it will introduce a new article of food to our poorer classes. Immense quantities are consumed in England, one firm in London purchasing seventy thousand bushels per annum. They are very prolific and are ravenous vegetarians. Oyster merchants use them to keep down the growth of seaweed in their oyster beds.

For the first time we record the discovery of two species of *Melanians* from Massachusetts. Specimens have been sent by William P. Alcott of North Greenwich, Conn., collected by him on the shores of Lanesboro Pond, Lanesboro, Mass. We identify *Melania Virginica* Say, and *Melania carinata* DeKay.

FUNCTIONS OF THE NERVE-CENTRES OF THE FROG. — Professor F. Goltz of Königsberg has been continuing his observations on the different nerve-centres of the frog. After removing the cerebrum with as little effusion of blood as possible, the frog remained on the table in exactly the position of a sound animal, and without any indication of the injury it had sustained; but, of its own accord, would never change the position once assumed. If pinched or pressed, it would turn itself round, or remove itself by a leap from the external pressure, but would then remain equally unchangeable in its new attitude. It can indeed be induced by external

means to go through actions which it would not ordinarily perform voluntarily, so that to a bystander it would almost appear to have undergone a course of training. Professor Goltz made some curious investigations on the source of the croaking power of the frog. Of its own accord it never croaks when deprived of its brain; but can easily be induced to do so by stroking it softly down the back from the front to the hinder part with the damp finger, every stroke being accompanied by a croak of satisfaction. From a number of such animals a complete concert of frogs can be obtained in this manner. The mutilated frog possesses also the power of preserving the equilibrium of its body. If placed on a book, to which a gradual inclination is given, it climbs to the upper edge, on which it supports itself by its forelegs, and repeats the process every time that the inclination is changed. Under similar circumstances an unmaimed frog would quickly hop to the ground. The movements of the frog, from which the brain has been removed, differ from those of the unmutilated animal in this respect, that they are performed mechanically, and with the regularity of a machine. It would also appear, from these experiments, that the nerve-centres for the voice and for the power of maintaining equilibrium reside, not in the brain, but in the spinal cord.—*Academy.*

THE COMPRESSED BURBOT OR EEL POUT.—In the March (1869) number of the NATURALIST is a paper with the above title by Wm. Wood, M.D. After giving the history, locality, number of specimens and their description, he then says: "The *Lota compressa* probably visits the salt water, as it is taken in ascending the Connecticut, or its tributaries, in the spring of the year in company with fish from the salt water ascending to spawn."

My first acquaintance with this rare fish was early in the spring of 1859. A specimen was brought me from West River, about a mile north of our village, where that stream joins with the Connecticut, and where it was "hooked up" while angling for other fish. Afterwards in 1864, another specimen was caught in the Connecticut River, opposite our village, with a baited hook set for eels. Both were of such extraordinary dimensions (being severally twelve and fourteen inches in length) that I published the fact, because I knew that the specimen of Lesueur, who first described the species was only six inches in length, and that of Storer who gave a description of a second specimen from Ashuelot River was eight inches long. As I had lived many years near these waters, and supposed myself to be well acquainted with their different denizens, and, moreover, had never seen this genus before, not even their fry, I was led to inquire whence they came.

It first occurred to me that they might have come up from the salt water, but the many impediments in the Connecticut, which are such well-known obstacles in the way of the migrations of fish, forbade at once the entertainment of this idea. Be that as it may, an incident has recently come to my notice which may shed some light on their early history, and certainly on one of their species.

On our farm is a swamp of about three acres, from which issues a rivulet, perhaps three feet wide and three to five inches deep. I have known for some years the existence of a peculiar fish in this little stream, for on approaching its banks I have often perceived quick efforts at concealment of something in the dark mud of the little pools along its coast. All my attempts to obtain a full view of the fish proved fruitless, but I judged by the ripples it made on the surface of the water, while passing shallow places that it must be some three or four inches in length. Recently whilst our woodchopper was at work in this swamp, he cut down a tree which fell into one of these pools, and a fish was thus thrown out upon the snow. It proved to be a veritable Lota about three and one-quarter inches long. It resembled *Lota compressa* in every particular, except that its thickness might have been greater in proportion to its length.

This rivulet empties into Whetstone brook, a stream ordinarily about two rods wide and two or three feet deep, and has a bed differing little from that of the Connecticut River. I have lived by this stream a number of years, and have never seen a Lota in its waters. The Whetstone empties into the Connecticut about a mile from the mouth of the rivulet. In this distance are two obstructions, partly natural and partly artificial, one thirty feet, the other twenty feet high, so that it cannot be supposed that there is any egress from the river to the rivulet by water.

The fishes of the Whetstone are *Salmo fontinalis* Mitch., *Rhinichthys atronasus* Agas., *Boleosoma Olmstedii* Agas., *Semotilus argenteus* Putn., *Plargyrus Americanus* Putn., and *Holomyzon nigricans* Agas.; the three latter were introduced by me some twenty years ago. I have been thus minute in giving all possible data, in order that a better judgment may be formed, whether these swamps are the breeding places of *Lota compressa*, or whether the specimen mentioned above may not be a new species.

The train of thought to which a solution of these questions might give rise, would naturally lead us to examine into the effects that purely local or particular causes may have upon the development and forms of fish life. With respect to the size of this specimen, being much smaller than those found in the Connecticut, we may say, that all fish of the same species found in large streams are generally larger than those found in small ones. We have a perfectly analogous example at hand in regard to the *Salmo fontinalis* of the Connecticut, which occurs of larger dimensions than in the Whetstone, the disparity being as striking in the latter case as in the former. — Charles C. Frost, *Brattleborough, Vt.*

A White Woodchuck. — It may interest you and some of your readers to know that I have obtained a perfectly white woodchuck, a perfect albino of *Arctomys monax* of Gmelin. There is not a dark hair on his body or tail, and his eyes are of a clear, rich, carnelian color. He was caught on North-west hill in Williamstown, Mass., and brought to me alive. From the first he fed freely on clover, especially the clover heads,

and made a nice nest for himself from the part discarded as food; in this nest he spent most of his time taking nearly the form of a ball. He always exhibited a readiness to bite, and it was not safe to touch him with the hand. One day I carried him, in his small cage, to my lecture room, and afterwards put him in my private room and left him alone. When I returned I found him out of the box or cage, and bottles and trays of natural history specimens scattered upon the floor. After disturbing things generally he had taken up his position behind a large box of fossils. From his retreat he looked as unconcerned as if nothing had happened. Without much trouble I secured him in his box again, and carried him home and put him in a large cage in my cellar which is well lighted and ventilated. About midway between the top and bottom of this cage is a shelf which touches the bars or slats in front, and extends backwards about half the depth of the cage. This shelf was put in so that the woodchuck might have something to rest upon besides the floor of the cage. After the cage was done it was desired to turn it so that what is naturally the back should be the bottom, the slats or bars thus being on the top instead of at the side; this brought the shelf into a vertical instead of a horizontal position. Now observe what this woodchuck did: he gnawed through the edge of this shelf, which was against the bars, in order to get into the other part of his cage, although there was a space of eight or ten inches below the lower edge of the vertical shelf for the whole width of the cage, and when he was disturbed he often run through this hole instead of going along on the bottom.

I was interested to see that he used everything he could get to enlarge and perfect his nest, not only all of his discarded clover stalks, and the rags which I gave him, but also all the chips which he gnawed from his cage. But he did not get thoroughly tamed, and so availing himself of the absence of a board, which had covered a hole which he had been gnawing, he squeezed out through the hole, scaled the cellar wall, and escaped through an open cellar window. A few weeks afterwards he was killed by a farmer's dog, and I have sent his skin to Mr. Jillson to be mounted.

Mr. Hitchcock of this town, informs me that he has seen a living white woodchuck in New Lebano, N. Y. — S. Tenney, *Williams College*.

Rare Birds in Nova Scotia. — I observe in the last number of the Naturalist a note on the occurrence of the *Pomarine Jager* (*Lestris pomarinus*), on the Susquehanna River, Pennsylvania, in July last. On the 4th of October, my friend, Mr. William Gilpin, shot a fine specimen at Digby, on the Bay of Fundy shore of this Province, which is now in my possession. I see in the "Report of the Birds of Massachusetts," that Dr. Brewer also obtained it some years ago in Massachusetts Bay.

Another rare visitor to a latitude so far north, was taken in our harbor about the time of the severe revolving southerly gale of the 30th of January last, the Purple Gallinule (*Gallinula martinica*, Baird). This is the first instance on record of its capture in Nova Scotia. — J. Matthew Jones, *Halifax, N. S.*

GEOLOGY.

Gigantic Fossil Serpent from New Jersey. — Professor Marsh describes in "American Journal of Arts and Sciences," under the name of *Dinophis grandis*, a new and gigantic snake from the Tertiary formation of New Jersey. He says "the earliest remains of Ophidia, both in Europe and this country, have been found in the Eocene, and nearly all the species from strata older than the Post Pliocene appear to be more or less related to the constricting serpents. Remains of this character are not uncommon in European rocks, but in this country two species only, one founded on a single vertebra, have been described hitherto, and both of these were discovered in the Tertiary greensand of New Jersey." The vertebra described "would indicate an animal not less than thirty feet in length; probably a sea-serpent allied to the Boas of the present era."

In closing, the author states that "the occurrence of closely related species of large serpents in the same geological formation in Europe and America, just after the total disappearance in each country of Mosasaurus and its allies, which show such marked ophidian affinities, is a fact of peculiar interest, in view of the not improbable origin of the former type; and the intermediate forms which recent discoveries have led paleontologists, familiar with these groups, to confidently anticipate, will doubtless, at no distant day, reward explorations in the proper geological horizon."

MICROSCOPY.

Microscope Objectives. — A performance of a 4-10 objective made for me by Mr. William Wales, of this city, is of such a superior character that I have no doubt it will be of interest to many of your readers. With direct or central light in contradistinction to oblique, and with the diatom mounted not dry, but in balsam, the *Pleurosigma angulata* is beautifully resolved; the three sets of lines being brought into view with great distinctness, and this with the No. 1 or A eye-piece. Amplification 210 diameters. With no equal power of Powell & Leland's of London, of Hartnack of Paris, of Tolles & Grunow of this country, or of Gundlach of Vienna, various objectives of each and all of which makers I have examined, have either, I myself, or other microscopists of my acquaintance been able to effect this. Another feat which I had recently the honor of exhibiting to several members of the "Bailey Microscopical Club" of this city was a resolution of the podura scale with its light central markings with this same 4-10. The resolution of the striæ on human muscular fibre by a 3-inch objective, also made by Mr. William Wales of this city, again challenges our admiration. — J. J. Higgins, M. D., 23 *Beekman Place, New York*.

[We referred this note to Mr. E. Bicknell, who kindly sends the following reply. — Eds.]

Messrs. Editors of the American Naturalist:—In answer to your question in regard to the above communication, I would say that while fully concurring with Dr. Higgins in his high estimation of Mr. Wales' objectives, I am of the opinion that he (Dr. Higgins) has either made an error in his measurement of amplification (210 diameters with the No. 1 or A eye-piece) or that the 4-10th objective is very much *underrated in magnifying power.* All of Mr. Wales' 4-10th objectives which I have seen have been as near or nearer 1-4ths than 4-10ths in magnifying power; and below I give a table of amplification of such 4-10th objectives as are at hand; also two 1-4ths for comparison:

Maker.	Angle of Ap.	Eye-pieces.		
		1.	2.	3.
4-10 J. Zentmayer, ...	75°	130	210	400
" Smith and Beck, ...	60°	135	220	415
" R. B. Tolles, ...	135°	125	205	390
" W. Wales, ...	110°	175	300	535
1-4 R. B. Tolles, ...	120°	200	325	615
" Smith and Beck, ...	75°	210	340	650

The measurements were made with a first-class stand and eye-pieces of Zentmayer, the image of a stage micrometer being thrown down by a Spencer's camera lucida, and measured at just ten inches from the eye; cover adjustment for 125th cover glass. It seems to me that there should be some uniform standard adopted by the different makers of objectives, so that the 1-4th of one maker may not be as high as the 1-6th of another maker; or a 4-10th of one be as high as a 1-4th of another; or, still worse, a 3-inch objective of one maker of *precisely the same power* as a 2-inch of another maker, which was just the case with two objectives which I had about one year since. If the objectives did not differ any more than the first three in the above table it would be an improvement. The amplification which Dr. Higgins gives to his 4-10ths is as high as the highest 1-4th in the above table. — Edwin Bicknell, *Salem.*

ANTHROPOLOGY.

The Bone Caves of Gibralter. — The four Genista Caves, Martin's Cave, St. Michael's Cave and some others, have yielded evidences of early man, in the form of osseous remains, associated with flint knives and flakes, stone axes, polished and chipped; worked bones, serving as skewers, arrowheads, needles and gouges; anklets or armlets of shell, hand-made pottery, querns, rubbing-stones and charcoal. With these were found remains of numerous animals,* including *Rhinoceros etruscus, Rh. leptorhinus* § (extinct); *Equus, Sus priscus* (extinct); *Sus scrofa, Cervus ela-*

* Those marked thus §, are abundant; and thus §§, very abundant. A single molar of *Elephas antiquus* was obtained many years since by the late Mr. James Smith, of Jordan Hill, in an old sea-beach (now demolished) at Europa Point, the southern extremity of the rock.

phus, var. *barbarus* §, *Cervus dama* §, *Bos* (a large form), and *Bos taurus* §; two forms of Ibex, *Capra Ægoceros* §§; and also the common goat, *Capra hircus; Lepus timidus, Lepus cuniculus* §§, *Mus rattus*. Of the carnivora were determined *Felis leopardus, Felis pardina, Felis serval, Hyæna brunnea, Canis vulpes, Ursus* sp.; also remains of the common dolphin, numerous genera and species of birds, a species of tortoise and numerous remains of fishes, of which the tunny is most prominent.

The remains are imbedded in red cave-earth and also in a black layer similar to that noticed in the caves of France and elsewhere. In many instances the organic remains have been carried down from one cavern to another at a lower level through long fissures, by the heavy autumnal floods which pour from the higher grounds down upon Windmill Hill plateau (where many of these ossiferous caves are situated), bringing with them the remains of the various animals which at an earlier period inhabited the thickly-wooded heights, now entirely destitute of trees and only covered at places by the little *Chamærops humilis*.

Many human and animal remains, attributable to modern periods, have been also met with; but the older human remains are distinguished by peculiarities in the thigh bones which closely resemble those met with in the Cro-Magnon Cave. — *Quarterly Journal of Science*.

ANSWERS TO CORRESPONDENTS.

W. H. S., Hummelstown, Pa. — The "Canadian Naturalist" is published monthly at Quebec, $2 a year gold. Address M. l'Abbé Provancher, Quebec, Canada.

C. J. S., St. Augustine, Fla. No. 1, *Pinquicula lutea*; 2, Nothing came with this number; 3, *Amianthium angustifolium*; 4, *Lupinus diffusus*; 5, *Pinquicula pumila*. See Chapman's Southern Flora. For naming, fair specimens should be sent, — not miserable and withered bits.

J. L. L., Boston. — Specimens of various species of sea-anemones with two mouths, each surrounded by its circle of tentacles, have often been observed and recorded in Europe. I have seen several instances of this kind in our native *Metridium marginatum*. It is, however, to be regarded as an abnormal condition, and appears in many cases to have been caused by some injury, which has been healed, leaving two disks instead of one. Spontaneous division occurs normally, however, in allied coral animals, and a disk-shaped sea-anenome is formed in the West Indies which naturally has two mouths (*Ricordea florida* Duch. and Mich.). — A. E. V.

W. H. S., Hummelstown, Pa. The shells sent are as follows, by your numbers: 1, *Helix monodon* Racket (Stenotrema); 2, *Helix tridentata* Say (Triodopsis); 3, *Helix alternata* Say (Anguispira); 4, *Helix bucculenta* Gld. (Mesodon); 5, *Helix albolabris* Say (Mesodon); 6, 7, *Anculosa dissimilis* Say; 8, *Goniobasis Virginica* Say (Melania); 9, *Paludina decisa* Say (Melantho); 10, *Sphærium sulcatum* Lam.; 11, *Planorbis bicarinatus* Say; 12, 13, *Margaritana undulata* Say; 14, *Unio complanatus* Sol.; 15, *Anodonta edentula* Say; 16, *Anodonta fluviatilis* Lea. — G. W. T., Jr.

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